Draft Consolidated Reconnaissance Report for Sharps Island For Potential Beneficial Use and Habitat Restoration

Sharps Island Lighthouse, 1885 (Source: US Coast Guard)

Prepared for:
Maryland Environmental Service

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EXECUTIVE SUMMARY

Sharps Island is being evaluated for a large-scale beneficial use of dredged material and habitat restoration site on the order of 1,000 to 2,000 acres in size. The historical Sharps Island footprint is under consideration as the original island completely disappeared in the early 1960s, possibly due to a variety of physical and environmental factors. Sharps Island is located approximately 4 miles south of Tilghman Island (Talbot County) and 4 miles west of Cook Point (Dorchester County) at the mouth of the Choptank River.

The Sharps Island investigation is being conducted under the Maryland Port Administration's Dredged Material Management Program (DMMP), formerly the Dredging Needs and Placement Options Program (DNPOP). Four separate studies were conducted to evaluate the use of dredged materials in this area in order to provide restoration of the island as well as create marsh and upland habitat areas in and around the island.

These four studies include:

1. *Reconnaissance Study of Environmental Conditions at Sharps Island* (ECR) - An environmental conditions assessment to document (including site visits, agency consultation, and literature review) environmental resources in the project area and determine the potential impacts of the proposed dredged material placement alternatives.

2. *Geotechnical Report for Sharps Island* (GR) - A study of the geotechnical conditions (including foundation and borrow source conditions at Sharps Island) of the area proposed for dredged material placement.

3. *Coastal Engineering Reconnaissance Study for Sharps Island, Maryland* (CERS) - A preliminary coastal engineering analysis for use in dredging engineering and dike design.

4. *Reconnaissance Study of Dredging Engineering and Cost Estimate for Habitat Restoration at Sharps Island (DECE)* - A study that provided a dredging engineering and cost analysis for each of the selected alternatives.

The proposed project would restore Sharps Island using dredged material from the Port of Baltimore and create upland and wetland habitats (on a 50%-50% basis by area). As part of the study, five potential dike alignments were examined, with dike heights varying from 7-10 ft. (for the wetland cells) to 10-20 ft. (for the upland cells). The site areas considered varied from 1,070 to 2,260 acres, with corresponding site capacities of 25 to 55 million cubic yards (mcy) for the 10-ft. dike, and 37 to 79 mcy for the 20-ft. dike, respectively.

From an engineering perspective, the construction of Sharps Island is technically feasible. The initial cost to construct the island ranges from $ 61 M to $136 M. Total site use cost ranged from $432 M to $1,250 M (for Alignments No. 5 and No. 2 respectively). Total unit cost ranged from $14.98/cy to $17.29/cy (for Alignments No. 4 and No. 5 respectively). Alignment No.4 with the upland portion constructed to +20 ft. provides the best unit cost ($14.98/cy) for the allotted storage capacity of approximately 50 mcy.

Alignment No. 5 with the upland portion constructed to +20 ft. provides the best unit cost for the allotted storage capacity of 37 MCY for a site not located within the oyster bar foot print. The total site use cost for Alignment No. 5 (constructed to +20-ft) would be $579 M and the total unit cost would be $15.85/cy.

1.0 INTRODUCTION

1.1 Project Description

MES, under sponsorship by the MPA, is examining potential sites throughout the Chesapeake Bay region to determine if they are suitable candidates for use as dredged material placement facilities. Several of the sites selected for this type of investigation are islands that have decreased significantly in size due to prolonged wave action or gradual sea level rise. Also, shorelines that have eroded over time due to similar environmental factors are considered for potential nourishment/beneficial use of dredged material.

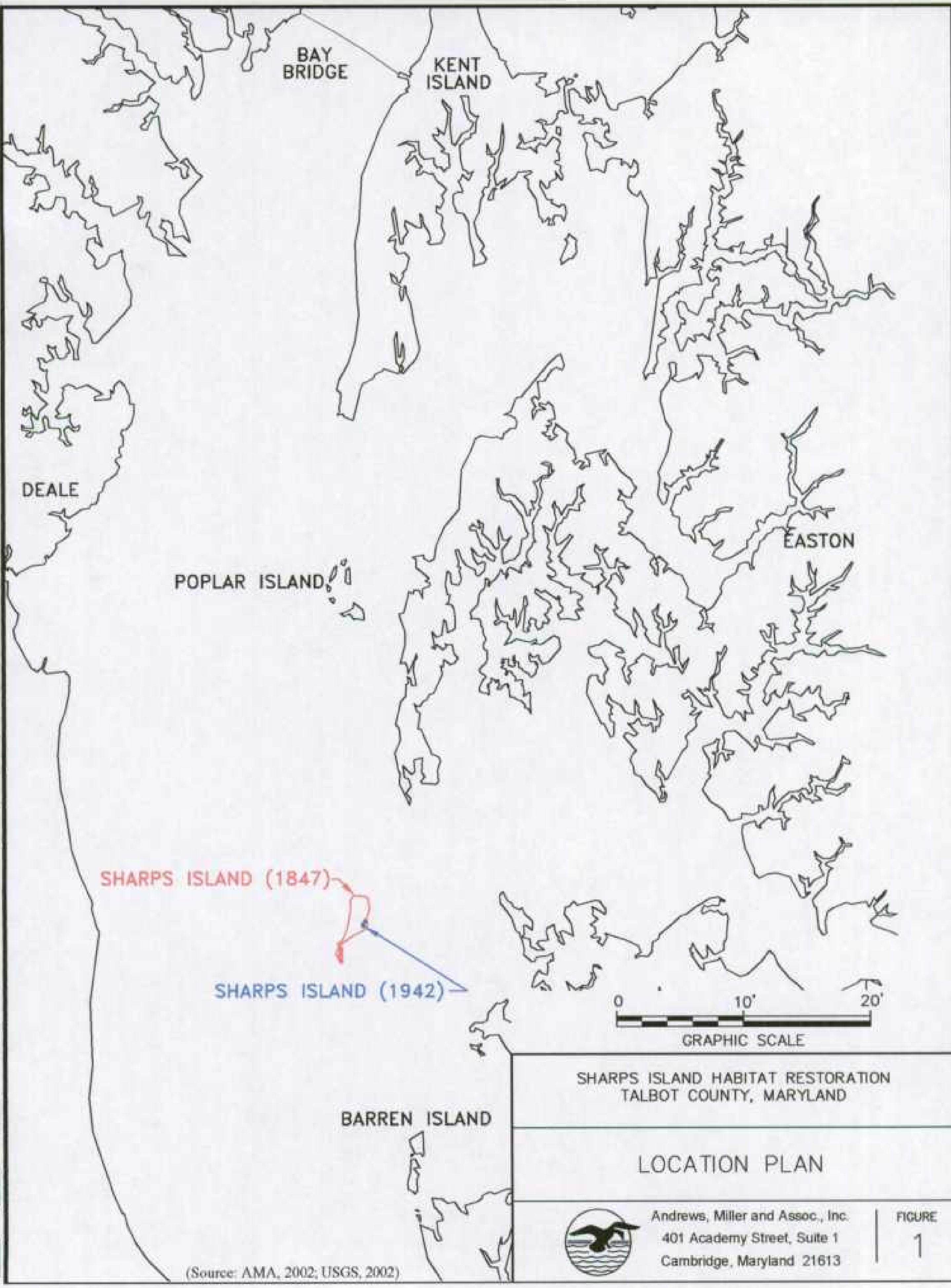
Sharps Island is being evaluated for a large-scale beneficial use of dredged material and habitat restoration site on the order of 1,000 to 2,000 acres in size. The historical Sharps Island footprint is under consideration for possible creation of a wetland and upland island habitat. The original island completely disappeared in the early 1960s, possibly due to a variety of physical and environmental factors (Hanks, 1975). Sharps Island is located approximately 4 miles south of Tilghman Island (Talbot County) and 4 miles west of Cook Point (Dorchester County) at the mouth of the Choptank River. Figure 1 presents the location of Sharps Island.

Three potential dike alignment options were initially reviewed in the Coastal Engineering Reconnaissance Report. Upon further investigation, one of the alignments was ruled out due to limited capacity. The alignment that was ruled out encompassed approximately 415 acres and would not meet the required capacity of 40 Million Cubic Yards (MCY) (even if the dikes were constructed to +20 ft with no wetlands).

AMA and BBL decided on three other dike options that would be reviewed. The three alignments range in size from 1,070 acres to 2,260 acres, and would meet the capacity requirement of 40 MCY to 80 MCY. The final five alignment options that were considered are shown in Figure 2.

Dike alignment options were based on geotechnical information gathered in the field (E2CR, 2002), the original 1847 foot print for Sharps Island and the proximity to NOB 14-4. Consideration was also given to the surrounding water depths. Constructing a rock revetment in deep water will increase the cost of the project significantly due to the quantity of stone that would be required in deeper waters. Therefore, keeping the foot print of the proposed island within the 12 ft contour tends to be the most economical.

<u>Dike Alignment No. 1</u> – Encompasses 1,840 acres and will be divided equally into uplands and wetlands (DECE Figures 4 and 5). The wetlands will be located to the eastern portion of the proposed island. When wetland construction is completed, the dikes may be breached to allow tidal flow in and out of the wetland cells. The east side of the dike is more protected so that waves approaching the breaches will be minimal compared to other directions. Approximately 1,455 acres of the proposed alignment is located within the oyster bar. The proposed dike alignment overlaps the original 1847 footprint by 277 acres. None of the 1942 footprint is located within the interior of the proposed alignment.

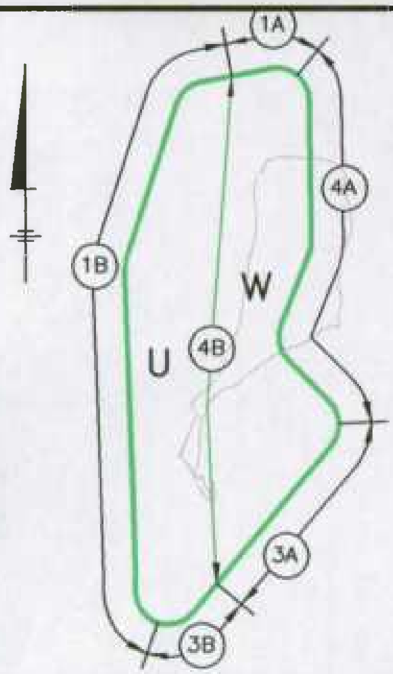


SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND

LOCATION PLAN

Andrews, Miller and Assoc., Inc.
401 Academy Street, Suite 1
Cambridge, Maryland 21613

FIGURE
1

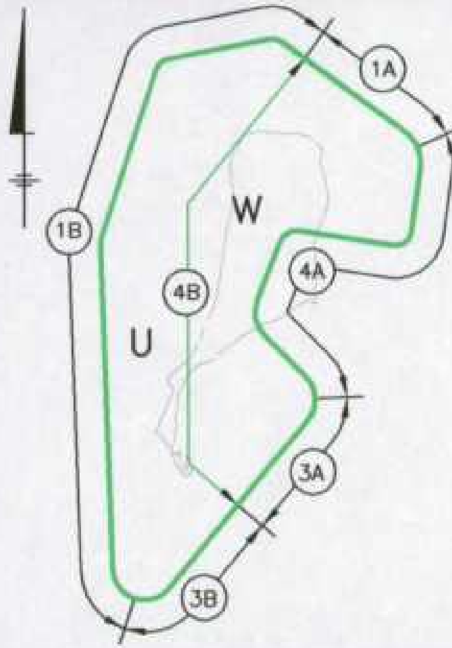


DIKE SECTION	DIKE LENGTH (FT)
1A	2,128
1B	18,627
3A	6,313
3B	2,385
4A	11,745
4B	15,714

LEGEND
U UPLAND – 920 Ac.
W WETLAND – 920 Ac.

ALIGNMENT 1

0 1500' 3000' GRAPHIC SCALE

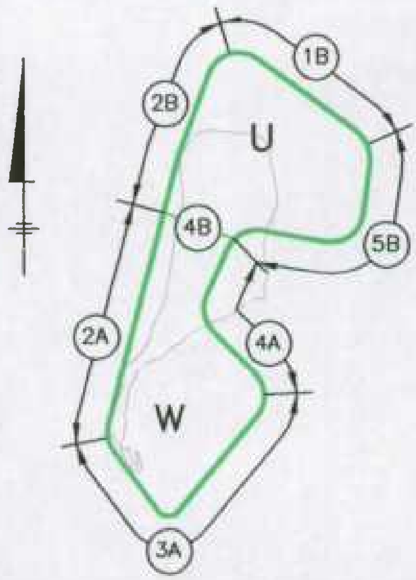


DIKE SECTION	DIKE LENGTH (FT)
1A	4,481
1B	21,927
3A	4,146
3B	3,399
4A	12,845
4B	15,775

LEGEND
U UPLAND – 1,130 Ac.
W WETLAND – 1,130 Ac.

ALIGNMENT 2

0 1500' 3000' GRAPHIC SCALE

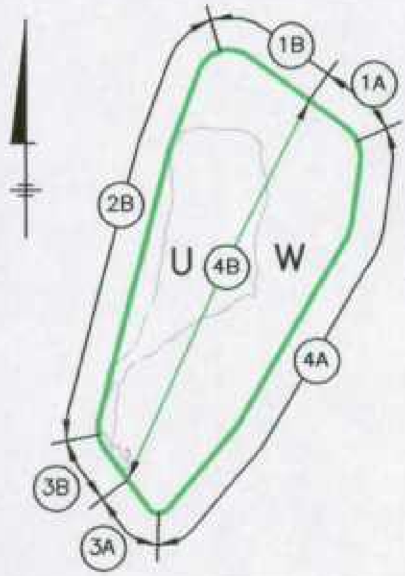


DIKE SECTION	DIKE LENGTH (FT)
1B	5,275
2A	7,252
2B	5,478
3A	8,084
4A	5,778
4B	2,349
5B	6,753

LEGEND
U UPLAND – 600 Ac.
W WETLAND – 600 Ac.

ALIGNMENT 3

0 1500' 3000' GRAPHIC SCALE

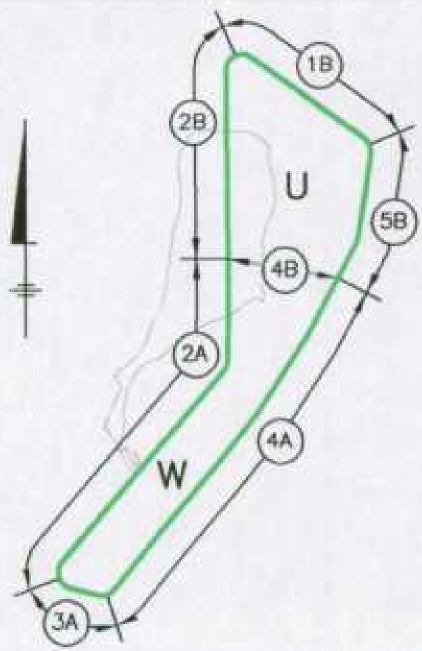


DIKE SECTION	DIKE LENGTH (FT)
1A	2,000
1B	3,274
2B	12,731
3A	1,443
3B	1,686
4A	13,572
4B	13,125

LEGEND
U UPLAND – 760 Ac.
W WETLAND – 760 Ac.

ALIGNMENT 4

0 1500' 3000' GRAPHIC SCALE



DIKE SECTION	DIKE LENGTH (FT)
1B	5,124
2A	11,865
2B	6,432
3A	1,648
4A	12,262
4B	3,475
5B	4,320

LEGEND
U UPLAND – 535 Ac.
W WETLAND – 535 Ac.

ALIGNMENT 5

0 1500' 3000' GRAPHIC SCALE

LEGEND

- PERIMETER DIKE
- LONGITUDINAL DIKE
- (3A) TYPICAL DIKE SECTION
- SHARPS ISLAND 1847 FOOTPRINT

SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
PROPOSED DIKE ALIGNMENTS

Figure 2

Dike Alignment No. 2 – Encompasses 2,260 acres and is divided equally into uplands and wetlands, (DECE Figures 6 and 7). The wetlands will be located on the eastern portion of the proposed island. The 420 additional acres were added on the northeast corner of Dike Alignment No. 1 to arrive at Dike Alignment No. 2. Approximately 1,460 acres of the proposed alignment is located within the oyster bar. Dike Alignment No. 2 would be breached similarly to Dike Alignment No.1. The proposed dike alignment overlaps the original 1847 footprint by 354 acres. None of the 1942 footprint is located within the interior of the proposed alignment.

Dike Alignment No. 3 – Encompasses 1,200 acres and is divided equally into uplands and wetlands, (DECE Figures 8 and 9). In this alignment, the uplands are located to the north and the wetlands are located to the south unlike the other alignments, the island is split in two by an east-west cross-dike. This configuration differs from the other two alignments because of the shape of the island and the concern of developing very long and narrow cells. Long and narrow cells may restrict inflow operations and flow of material to the outer extents away from the inflow locations. Another difference between Dike Alignment No.3 and the previous two options is that the overall footprint located within the oyster bar has been reduced. The breaching of the dikes, to allow tidal interaction with the wetland cells, would occur along the south west portion of the dike. Approximately 565 acres of the proposed alignment is located within the oyster bar. The proposed dike alignment overlaps the original 1847 footprint by 354 acres. None of the 1942 footprint is located within the interior of the proposed alignment.

Dike Alignment No. 4 – Encompasses 1,520 acres and is divided equally into uplands and wetlands (DECE Figures 10 and 11). The wetlands will be located on the eastern portion of the proposed island and breached in a manner similar to Alignments 1 and 2. Approximately 600 acres of the proposed alignment is located within the oyster bar. The proposed dike alignment overlaps the original 1847 footprint by 439 acres. The entire 1942 footprint is located within the interior of the proposed alignment.

Dike Alignment No. 5 – Encompasses 1,070 acres and is divided equally into uplands and wetlands similar to Alignment Option 1 and 2 (DECE Figures 12 and 13). The main difference is that the uplands are located to the north and the wetlands are located to the south. Another significant difference is that the entire site is located outside the oyster bar. The oyster bar and the proposed alignment share two common sides (i.e., the eastern and southeastern edges of the oyster bar). The proposed dike alignment overlaps the original 1847 footprint by 152 acres. The entire 1942 footprint is located within the interior of the proposed alignment.

1.2 Consolidated Report Purpose and Format

The purpose of this Consolidated Report is to consolidate the findings from four individual reports completed for the Sharps Island area located in the Chesapeake Bay in Talbot County, MD. These reports include:

- *Coastal Engineering Reconnaissance Study for Sharps Island, Maryland* (CERS) prepared by Andrews, Miller & Assoc., Inc., August 2002.

- *Reconnaissance Study of Dredging Engineering and Cost Estimate for Habitat Restoration at Sharps Island* (DECE) prepared by Blasland, Bouck & Lee, Inc. for Andrews, Miller & Assoc., Inc., September 2002.
- *Geotechnical Report for Sharps Island* (GR) prepared by E2CR, Inc. for Moffat & Nichol Engineers, June 2002.
- *Reconnaissance Study of Environmental Conditions at Sharps Island* (ECR) prepared by Blasland, Bouck & Lee, Inc. for Andrews, Miller & Assoc., Inc., September 2002.

In order to retain the true intent of the language used in the various reports that comprise this Consolidated Report, little textual change has been made to the original language used in the various reports. Most of this report has been excerpted verbatim from these reports. References are generally provided at the end of each paragraph to specify the report and page referenced. The original four reports utilized for this consolidated report are provided as attachments (see Appendices A - D) and should be consulted directly for tables, figures, and detailed discussions of the various topics summarized by this report.

2.0 RECONNAISSANCE STUDIES

2.1 Coastal Engineering Reconnaissance Study (CERS)

The *Coastal Engineering Reconnaissance Study for Sharps Island, Maryland* was prepared by Andrews, Miller & Associates, Inc. in August 2002, and provides background and coastal engineering design guidance for the Sharps Island beneficial use project. The report addresses two major needs of the project: 1) identification and evaluation of available data that can be used to describe environmental (meteorological and hydrological) conditions at Sharps Island; and 2) design parameters (i.e., stone size and dike elevation) of the proposed preliminary dike alignments based on the environmental conditions. To optimize shore protection design, an evaluation of local wind, wave, and storm surge conditions impacting this site was performed. In addition, preliminary dike heights and armor stone sizes were determined for the 35-year design (CERS p.18).

2.2 Reconnaissance Study of Dredging Engineering and Cost Estimate for Habitat Restoration at Sharps Island (DECE)

The *Reconnaissance Study of Dredging Engineering and Cost Estimate for Habitat Restoration at Sharps Island* was prepared by Blasland, Bouck & Lee, Inc. in September 2002. BBL evaluated the suitability of this site to construct a beneficial habitat restoration dredged material placement facility. Each preliminary dike alignment included a 10 and 20 foot high upland dike height option. BBL also provided a dredging engineering assessment for constructing an environmental restoration beneficial use site at Sharps Island. This report outlines the findings of the assessment.

Specifically, BBL's tasks included the following items (DECE p.2-1):

- Review the Geotechnical Report prepared by Engineering, Construction, Consulting and Remediation (E2CR, 2002) to assist in determining the sand borrow options. The method of excavation, transport and dike section placement will be reviewed.

- Examine five potential dike alignments to create a containment facility that will encompass 1,000 to 2,000 acres, capable of receiving 40 to 80 million cubic yards of dredged material over the life of the project. The footprint will be split into two equal portions, 50% uplands and 50% wetlands. The upland dikes will be reviewed for two different final elevations, +10 ft and +20 ft. The wetland portion of the dikes will be either +7 ft or +10 ft.

- Review the Coastal Engineering Reconnaissance report prepared by AMA (2002) to determine the dike height and the size of stone that will be used for the revetment structure. The investigation will also examine the existing bathymetry, topography, wind conditions, water levels, currents and sediment data with regard to the effects on the dike construction at the site.

- Estimates of neat quantities of material will be made for the following:
  - Dike fill material.
  - Revetment stones (quarry run, toe armor, underlayer stone and slope armor stone).
  - Stone for roadway construction.
  - Geotextile for revetment and roadway construction.
  - Number of spillways required for effluent discharge to the bay and interior island spillways.
  - Unsuitable foundation material to be removed and replaced with clean fill.

  The dike construction materials, areas and volumes, will be estimated from the information provided from the report prepared by AMA, (2002). The unsuitable foundation material quantities will be estimated from the geotechnical report prepared by E2CR, (2002).

A cost estimate will be made to determine the costs associated with dredging material from the Baltimore Harbor approach channels east of the North Point-Rock Point line, and for transport and placement at the proposed facility. The estimate will also include the following: planning and design of the facility, habitat monitoring during the life of the project, planning and construction of wetlands, planting the wetlands and operations and maintenance of the facility. The cost for constructing the dike will be examined for two different methods. The first method will be to hydraulically pump suitable dike construction material directly into the dike template and the second will be to hydraulically stockpile material in a suitable location and mechanically haul and place the material in the dike template.

2.3 Geotechnical Report (GR)

The *Geotechnical Report for Sharps Island* (GR) was prepared by Engineering Consultation Construction Remediation, Inc. (E2CR, Inc.) for Moffat & Nichol Engineers in June 2002.

The purpose of the GR was to:

- Evaluate the geotechnical conditions at the site, especially along the proposed alignments.
- Design a stable dike section at the site in order to establish a preliminary cost estimate for developing the site.
- Evaluate the availability of borrow material (sand) at the site, for the construction of the dike.

The scope of this study included reviewing available data from sources such as the Maryland Geological Survey (MGS) and Soil Conservation Service (SCS), drilling 27 borings, obtaining Shelby tube samples, and conducting in-situ vane shear strength tests at 7 locations. The next steps in the process included laboratory tests to determine the substrate stress history, determining the strength characteristics and index properties of various strata, evaluating the data, conducting slope stability analyses for the proposed containment dike, and evaluating the soils at the site for possible use in constructing the dike. The final step was the development of a dike section for use in preparing a cost estimate (GR p.2).

2.4 Environmental Conditions Report (ECR)

The *Environmental Conditions Report* for Sharps Island, prepared by Blasland, Bouck & Lee, Inc. September 2002, evaluates the current environmental conditions in the vicinity of Sharps Island. This study also evaluates the potential positive and negative environmental impacts associated with five conceptual environmental restoration area configurations that would provide marsh and upland habitat area creation and habitat restoration. The assessments were based on an evaluation of existing literature and databases, site visits, and interviews and correspondence with Federal and state agencies (ECR p. 1-1).

3.0 RESULTS OF RECONNAISSANCE STUDIES

Each of the following sections contains a general discussion followed by site-specific information on the proposed alignments, if applicable.

3.1 Location

Sharps Island is located in the southern part of the Chesapeake Bay near the mouth of the Choptank River, the largest river on the Eastern Shore of Maryland. The island is located in Talbot County, Maryland, approximately 4 miles southwest of Blackwalnut Point, and approximately 4 miles west of Dorchester County.

Sharps Island Light marks the shoal of what once was a 900+ acre island in the Chesapeake Bay off the entrance to the Choptank River (Hanks, 1975). During the 19th century, Sharps Island was noticeably decreasing in size, possibly due to a variety of physical and environmental factors. By 1848, approximately half of the Island's acreage had been lost (ECR Figure 1-2). Due to encroaching waters, the original lighthouse was replaced in 1866 and relocated 1/3 of a mile off the northern tip of the Island (USCG, 2002). By 1900, less than 100 acres remained. Sharps Island was reduced to approximately 10 acres by 1942. Finally, the last remaining land of Sharps Island disappeared under the waters of the Chesapeake Bay in the early 1960s (Hanks, 1975). Water depths in the Sharps Island 1848 historic footprint vary from approximately –5.0 to –11.0 feet Mean Lower Low Water (MLLW) (AMA, 2002).

The proposed concept areas are presented in the Reconnaissance Study of Dredging Engineering and Cost Estimate for Habitat Restoration at Sharps Island (DECE p.3-2). There are five proposed dike sections. All proposed sections are divided equally into uplands and wetlands. Three of the proposed dike alignments range in size from 1,520 to 2,260 acres.

In these concept areas, uplands will be located in the western portion and wetlands will be located in the eastern portion of the proposed islands. The remaining two dike alignments are 1,070 and 1,200 acres in size. In these concept areas, uplands are located to the north and wetlands are located in the southern portion of the proposed islands.

All of the proposed dike alignments partially overlap the original 1848 footprint. In the proposed concept areas, water depths are shallower along the east and south shorelines, with water depths ranging from –8.0 to –10.0 feet MLLW. Depths along the west and north sides are deeper, ranging between –11.0 and –14.0 feet MLLW. A portion of these alignments are located within the natural oyster bar in the vicinity of Sharps Island (CER p.2).

<u>Dike Alignment No. 1</u> – Encompasses 1,840 acres and will be divided equally into uplands and wetlands (DECE Figures 4 and 5). The wetlands will be located to the eastern portion of the proposed island. Approximately 1,455 acres of the proposed alignment is located within Natural Oyster Bar 14-4. The proposed dike alignment overlaps the original 1847 footprint by 277 acres. None of the 1942 footprint is located within the interior of the proposed alignment.

Dike Alignment No. 2 – Encompasses 2,260 acres and is divided equally into uplands and wetlands, (DECE Figures 6 and 7). The wetlands will be located on the eastern portion of the proposed island. The 420 additional acres were added on the northeast corner of Dike Alignment No. 1 to arrive at Dike Alignment No. 2. Approximately 1,460 acres of the proposed alignment is located within the oyster bar. The proposed dike alignment overlaps the original 1847 footprint by 354 acres. None of the 1942 footprint is located within the interior of the proposed alignment.

Dike Alignment No. 3 – Encompasses 1,200 acres and is divided equally into uplands and wetlands, (DECE Figures 8 and 9). In this alignment, the uplands are located to the north and the wetlands are located to the south unlike the other alignments, the island is split in two by an east-west cross-dike. One difference between Dike Alignment No. 3 and the previous two options is that the overall footprint located within the oyster bar has been reduced. Approximately 565 acres of the proposed alignment is located within the oyster bar. The proposed dike alignment overlaps the original 1847 footprint by 354 acres. None of the 1942 footprint is located within the interior of the proposed alignment.

Dike Alignment No. 4 – Encompasses 1,520 acres and is divided equally into uplands and wetlands (DECE Figures 10 and 11). The wetlands will be located on the eastern portion of the proposed island. Approximately 600 acres of the proposed alignment is located within the oyster bar. The proposed dike alignment overlaps the original 1847 footprint by 439 acres. The entire 1942 footprint is located within the interior of the proposed alignment.

Dike Alignment No. 5 – Encompasses 1,070 acres and is divided equally into uplands and wetlands (DECE Figures 12 and 13). The main difference is that the uplands are located to the north and the wetlands are located to the south. Another significant difference is that the entire site is located outside the oyster bar. The proposed dike alignment overlaps the original 1847 footprint by 152 acres. The entire 1942 footprint is located within the interior of the proposed alignment.

3.2 Summary of Coastal Engineering Reconnaissance Study (CERS)

3.2.1 Design Parameters

3.2.1.1 Bathymetry

Digital hydrographic data were obtained from the National Ocean Service GEODAS (GEOphysical DAta System). This digital data includes all of the National Oceanic and Atmospheric Administration (NOAA) bathymetry utilized to generate the local navigation charts and provides detailed information for the study area.. Analysis of this data indicates that water depths are shallower along the east and south shorelines of the proposed dredged material placement island dikes, with depths ranging from –8.0 to –10.0 feet MLLW. Depths along the west and north sides are deeper, ranging between –11.0 and –14.0 feet MLLW (CERS p.2).

3.2.1.2 Wind Conditions

Wind data was obtained from a 32-year data set from Baltimore-Washington International Airport. The wind data set included the fastest mile peak daily wind gusts over this period. To determine the return frequency of various extreme wind events, a extremal analysis of the data set was performed based on a Gumbel distribution. Distributions were developed for each of the primary wind directions. Since the primary purpose for developing wind conditions is to assess the local wave climate, fastest mile wind speed was converted to one-hour wind speed for input to the U.S. Army Corps of Engineers Automated Coastal Engineering System (ACES) (CERS p.7).

Design winds were developed for each of the eight primary directions (N, NE, E, SE, S, SW, W, and NW) for return periods of 5, 10, 25, 50, and 100 years (CERS p.9). One-hour wind speeds ranged from 27.2 mph (E) to 43.3 mph (NW) for the 5-year return period; 31.8 mph (E) to 47.5 mph (NW) for the 10-year return period; 38.6 mph (E) to 55.5 mph (SW) for the 25-year return period; 44.6 mph (E) to 64.1 mph (SW) for the 50-year return period; and 51.9 mph (E) to 74.7 mph (SW) for the 100-year return period. A complete listing of the design wind speeds for each of the eight primary directions and 5 return periods are presented on page 9 of the CERS.

3.2.1.3 Storm Surge

Tides in the Sharps Island area are semi-diurnal (twice daily), with a mean tide range of 1.35 feet and the mean tide level is 0.76 feet above MLLW. Design water levels for coastal engineering structures incorporate storm surge. Based on data developed by the Virginia Institute of Marine Science (VIMS) from a comprehensive evaluation of storm-induced water levels utilizing a numerical hydrodynamic model, the estimated 50-year surge elevation is 4.6 feet above mean sea level and the 100-year surge level is 5.4 feet above mean sea level (CERS p.11).

3.2.1.4 Wave Conditions

The Sharps Island area is impacted primarily by wind-waves generated in the Chesapeake Bay. Using historical wind data from Baltimore-Washington International Airport as input to the USACE ACES wave hindcasting program, design wave conditions were developed based on radially averaged fetch distances and depths for the N, NE, E, SE, S, SW, W, and NW sectors. Fetch depths were determined using NOAA bathymetry data from surveys of the Chesapeake Bay. Wave conditions were determined for the 5, 10, 25, 50 and 100 year return periods. This analysis included storm surge levels above the mean fetch depth for each of the modeled return periods (CERS p.11).

For the Sharps Island site, the highest waves are estimated to approach from the South, where the 100-yr return wave height was computed to be 12.4 ft, with a peak period of 7.1 seconds. For the same southerly exposure, the 35-yr return wave height is estimated to be 10.0 ft. with a peak period of 6.4 seconds. These wave height design parameters incorporate the effects of storm surge levels as reported by VIMS (CERS p.15).

3.2.1.5 Dike Construction

Cross-sections for the proposed alignments are shown in CERS Figures 12 and 13. The dimensions of the dike reflect the stones sized for a 35-year design life, and a 3H:1 V outer slope. The structure core is constructed using sand, and is separated from the overlying armors and underlayers by an additional layer of geotextile fabric. A 20-ft wide, 8-inch thick crushed stone roadway is provided at the crest of the dike (CERS p.25).

Alignment No.1

The total dike length for Alignment No.1 is approximately 41,200 linear feet. For the 10-foot dike, the total capacity for Alignment No.1 is 45 million cubic yards (DECE Table 1) and for the 20-foot dike, the total capacity is 65 million cubic yards (DECE Table 1).

Alignment No.2

The total dike length for Alignment No.2 is approximately 46,800 linear feet. For the 10-foot dike, the total capacity for Alignment No.2 is 55 million cubic yards (DECE Table 2) and for the 20-foot dike, the total capacity is 79 million cubic yards (DECE Table 2).

Alignment No.3

The total dike length for Alignment No.3 is approximately 38,600 linear feet. For the 10-foot dike, the total capacity for Alignment No.3 is 29 million cubic yards (DECE Table 3) and for the 20-foot dike, the total capacity is 42 million cubic yards (DECE Table 3).

Alignment No.4

The total dike length for Alignment No.4 is approximately 34,700 linear feet. For the 10-foot dike, the total capacity for Alignment No.4 is 34 million cubic yards (DECE Table 4) and for the 20-foot dike, the total capacity is 50 million cubic yards (DECE Table 4).

Alignment No.5

The total dike length for Alignment No.5 is approximately 41,700 linear feet. For the 10-foot dike, the total capacity for Alignment No.5 is 25 million cubic yards (DECE Table 5) and for the 20-foot dike, the total capacity is 37 million cubic yards (DECE Table 5).

3.2.1.5.1 Dike Design Values

Per typical design procedures, dike designs depend upon wave and tidal hydrodynamic conditions at the site for an appropriate return period event. Typical coastal projects for the Corps of Engineers are designed at the 50-year to 100-year return period design level. However, based on similar analyses for Poplar (GBA, 1995) and Parsons Islands (Moffatt & Nichol Engineers (2001), a 35-year return period for winds and storm surge elevations was chosen for those sites as the design return period to optimize the dike design. Accordingly, for this conceptual design study, the 35-year return period for winds and storm surge elevations is used as the design return period. Dike crest elevations and stone sizes are presented also for the 5-, 10-, 25-, 50-, and 100 year return conditions for comparison. (CERS pp.18-21)

3.2.1.5.2 Dike Crest Height

The primary functions of the proposed dike enclosure are to provide a dredged material placement area for the hydraulic placement of suitable dredged sediments and to protect the dredge fill from wave and tidal action. Given the combination of waves and surge, it is probable that some amount of water will overtop the crest during the course of a severe storm event (CERS p.18). From a functional design perspective, the final dike crest elevation must be selected in accordance with an allowable overtopping rate of water, i.e., the lower the acceptable overtopping rate, the higher the design dike crest. The method presented by Van der Meer (1992) was used to determine the dike crest elevation for a structure with a 3H:1V slope. For an allowable overtopping rate of water for the 35-year project design conditions, the estimated dike height is approximately 10 ft. (MLLW) for the North and West dike sections, 12 ft. (MLLW) for the South dike section and 7 ft. (MLLW) for the East dike section. The reduced height of the eastern section is the result of lower waves from the eastern wave fetch direction. (CERS p.21)

From a dredged material perspective, the proposed dike sections are broken into two designations, A and B. Typical dike sections 1A-6A are for a facility that will be constructed to an elevation of +10 ft MLLW for the upland portion and to +10 or +7 ft MLLW for the wetland portion. Typical dike sections 1B-5B are for a facility that will be constructed to an elevation of +20 ft MLLW for the upland portion and to +10 or +7 ft MLLW for the wetland portion. The perimeter dike sections are 1A-4A, 6A, 1B-3B, and 5B. The interior crossdikes/longitudinal dikes are 5A and 4B. Again, the designation of "A" and "B" is the difference in dike design between +10 ft and +20 ft respectively. Only the upland portion would potential be raised to +20 ft MLLW. Wetland dikes are typically lower than +10 ft, because the marsh elevations are typically lower than 2.5 ft. The perimeter dike elevation (for the wetland cells) is primarily a function of wave height and wave run-up and is not controlled by site capacity. The typical dike sections are shown in DECE Figures 14 to 19.

3.2.1.5.3 Armor Stone Sizing

As discussed in previous reports, several methods have been developed to determine armor stone size requirements for dikes and revetments. Similar to the previous studies for Parsons and Poplar Islands, the method of Van der Meer (1988) was utilized in this study. As in the dike crest determination, for the purpose of stone sizing, wave conditions from the south, northwest, and northeast were selected, as they represented the largest offshore wave conditions approaching the dike. The southern wave condition was used for the South dike section, the northwestern wave condition was used for the North and West dike sections, and finally the northeast wave condition was used to size the East section of the dike. Stone weights and sizes for the evaluated return periods are presented in CERS Tables 13 and 14, respectively.

For the 35-year design return period, the approximate stone weight (and average dimension) for Alignment 1 along the North, West, and South portions of the dike varies between 1.16 tons (2.4 ft.) and 2.52 tons (3.1 ft.), with 0.63 tons (2.0 ft.)for the eastern dike section, which is more sheltered. For Alignments 2 and 3, there is a similar range in stone weights between the North, East and South dike sections. However, the estimated stone weight for the West section of Alignments 2 and 3 is lower, 1.2 tons (2.4 ft.) due to the shallower depth at the toe of the dike (CERS p.22).

3.2.1.5.4 Toe Protection and Underlayer

Toe stone sizes were computed based on the MLLW level condition. Waves were evaluated without including storm surge since the hydrodynamic forces on the dike toe would be greatest when waves are directly plunging on the toe. From this analysis, the required stone weights for the North and West sections of the dike are 0.8 tons and 0.3 tons for the East and South sections for Alignment 1 for 35-year return period waves with a still water elevation corresponding to MLLW. For Alignments 2 and 3, there is a similar range in stone weights between the North, East and South dike sections. However, the estimated toe stone weight of the West section of Alignments 2 and 3 is lower, 0.3 tons due to the shallower depth at the toe of the dike (CERS p.22).

An underlayer of finer sized stone is included as part of a dike design based on the USACE recommendation that the underlayer be composed of stones within the range of 0.07 to 0.10 times the weight of the overlying armor to ensure surface interlocking with the armor stones which enhances the stability of the armor layer (CERS p.22).

3.3 Summary of Geotechnical Report (GR)

The sediment borings indicate that at the site there are several subsurface re-deposited erosion channels where the subsurface conditions along the perimeter of the dike and in the potential borrow area (within the diked area) are significantly different. The subsurface conditions in the un-eroded areas and in the erosion channel areas are therefore, discussed separately.

3.3.1 Un-Eroded Geologic Areas

The borings indicate that the subsurface stratigraphy in the regular geologic areas generally consists of three major strata, as shown on GR Figures 9 and 10 - Generalized Subsurface Profiles.

Stratum II: This stratum consists of very loose to dense, brown-gray, Clayey Sand with pockets/layers of Silty Sand. The standard penetration resistance (N value) varies from Weight-Of-Rods (WOR) to over 50 blows/ft., and is generally between 2 blows/ft. to 6 blows/ft. This stratum is fairly consistent through out the site, except in the erosion channel areas. The thickness of this stratum varies from about 6-ft. to about 13-ft. (GR p.7).

Stratum IIIa: This stratum consists of loose to dense, gray, brown slightly silty to silty sand with pockets of silty clay. The standard penetration resistance varies from about 6 blows/ft. to over 50 blows/ft. but is generally between 12 blows/ft. and 40 blows/ft. Its thickness varies considerably from zero to 40+ feet (bottom of the borings) in several borings (GR p.8).

Stratum lllb: This stratum consists of grayish brown to greenish gray Clayey Silt/Silty Clay with pockets/layers of gray brown, green gray Silty Sand. It underlies Stratum Ia, Stratum Ib or Stratum II in certain areas of the site. The N values vary considerably from WOR to 46 blows/ft., but are generally between 5 blows/ft. and 22 blows/ft. The stratum is pre consolidated (GR p.8).

3.3.2 Erosion Channel Area

Along the perimeter of the dike alignments, the erosion channels were mainly encountered in borings S-2, S-3, S-4, S-11, S-12, S-13, S-23 and S-24 (GR Figure 5). The subsurface conditions in the erosion channel area are highly variable. The subsurface condition generally consists of the following two strata:

Stratum Ia: This stratum consists of very loose to loose brown to grayish brown Silty Sand with layers/pockets of Clayey Sand: The standard penetration resistance (N value) varies from WOR (Weight of rods) to 10 blows/ft., and is generally between WOR to 4 blows/ft. This stratum is fairly consistent through out the site, except in the erosion channel areas. The thickness of this stratum varies from about 3-ft. to 27-ft. The stratum is highly discontinuous in the erosion channels and is believed to be the redeposited soil in the erosion channels of Stratum II and Stratum III (GR p.9).

Stratum Ib: This stratum consists of brown to grayish brown to gray Clayey Silt/Silty Clay with pockets/layers of gray brown, Silty Sand. It mainly underlies Stratum la, but it was also encountered at the surface in borings S-19 and S-26. The Stratum was encountered at a depth of 0-ft. to 27-ft. below the surface and the stratum is 5-ft. to over 40-ft. thick (bottom of the borings). The N values vary considerably from WOR to I1 blows/ft., but are generally between WOR and 4 blows/ft. The stratum is normally consolidated to slightly pre consolidated. This stratum is highly discontinuous and is believed to be the redeposited soil in the erosion channels of Stratum II and Stratum III (GR p.10).

The borings indicate that the sand, in general, is semi angular to angular. The fines content varies from about 5% to 50%, and is generally less than 30%. The sand is Clayey in some areas, and also contains pockets/layers of clay. The sand is considered to be suitable for building the dike. The suitable sand is available in Stratum la, Stratum II and in Stratum Ma. It should be noted that in some areas, such as borings S-7, S-8, S-9, S-10, S-13, S-14, and S-15, the sands are very dense, i.e. in excess of 50 blows/foot. Dredging these very dense sands could be somewhat difficult (GR p.12).

The locations of the potential borrow areas are shown on GR Figure 11. The volume of total sand available is estimated to be about 20 million cubic yards. During construction, the bulking will be minimal, since the sand is loose. In addition, about 20% of the fines will be lost. Therefore, the net quantity of sand available for dike construction is estimated to be about 16 million cubic yards. It appears that adequate sand is available to build the dikes to El. 20 (GR p.12).

Slope stability analyses were conducted using one typical case for the subsurface profile. The Purdue University PC STABL-5M program was used to analyze the stability of the slopes. Failures can be analyzed using different approaches, such as the Modified Bishop Method, the Modified Janbu Method and the Spencer Method. For this study, the Modified Bishop method was used (GR p.13).

Along the dike alignments, different foundation conditions were encountered. All dike sections were analyzed for circular failures. During construction, the slope of the dike can vary considerably, depending upon the type of soil, placement methodology, and whether the soil is placed above or below the water. Past experience has indicated that dikes constructed from Silty Sands (nonplastic) can achieve slopes as steep as 2H: IV below the water. However, 3H: IV is a more realistically obtainable slope. For this pre-feasibility phase, it was assumed that the dike would be constructed by hydraulic dredging, and the slopes achievable would be 3H: 1V above and below the water table.

Based on the limited boring data, the following is concluded (GR p.16):

i) The foundation soils, except in the erosion channel areas, are anticipated to be mostly loose to dense Clayey Sands (Stratum II) underlain by loose to dense Silty Sands (Stratum Ma), except near S-14, S-17, S23 and S-24, where the clayey sands (Stratum II) are underlain by Silty Clay (Stratum IIIb).

ii) The Silty Sands of Stratum II and IIIa and the Silty Clay of Stratum IIIb are considered to be suitable fbr supporting the proposed dikes with exterior slope of 3H :1V and the top of dike at El. + 20.

iii) In the erosion channel areas, the soils of Stratum Ia and Ib are not suitable for supporting the dike and the dike may have to be re-aligned or staged construction with wick drains may have to be used. However, the Silty Sands of Stratum Ia are suitable for use as borrow.

iv) A total of about 20 million cubic yards of Silty Sand / Clayey Sand and a net .(i.e. assuming 20% loss of fines during hydraulic dredging and placement) of about 16+ million cubic yards of Silty Sand / Clayey sand is estimated to be available within the diked area.

3.4 Summary of Reconnaissance Study of Dredging Engineering and Cost Estimate (DECE)

3.4.1 Borrow Material

The estimated neat dike fill quantities for construction of the perimeter dikes with the various alternatives are summarized as (DECE p.4-1):

Alignment No.	Material required for dike construction (10 ft, mcy)	Material required for dike construction (20 ft, mcy)
1	3.8	5.9
2	4.4	6.7
3	2.6	3.7
4	2.8	4.3
5	2.5	3.2

Two sand sources were reviewed. Alternative 1 involves mining sand from an on-site borrow source using a hydraulic dredge. Alternative 2 involves using a clamshell dredge to mine the sand from an off-site source, and then transport the material to the site via a scow.

Under Alternative 1, the mined sand will be stockpiled and hauled by truck, and placed mechanically (or pumped hydraulically) into the dike template. Under Alternative 2, the mined sand (possibly in the Craighill Channel) will be transported to the site and dumped and placed in deep water. The material would be stockpiled underwater and then moved a second time by a hydraulic dredge and pumped into template (DECE p.4-1).

The quantity of material located within the footprint for each alignment option and the quantity of material located outside the footprint are summarized below (DECE p.4-1):

Alignment No.	Material inside the footprint (mcy)	Material outside the footprint (mcy)
1	11.0	10.0
2	19.0	2.0
3	5.5	15.5
4	5.0	16.0
5	6.6	14.4

Based on a review of the Geotechnical Report (E2CR, 2002), it appears that there will be ample sand on-site for dike construction.

3.4.2 Cost Estimate

The costs associated with the construction of Sharps Island are based on the proposed dike alignments, typical dike sections, and the equipment that will be required for construction of the island. The unit costs used for the estimate are based on similar reconnaissance level projects in the Chesapeake Bay, and actual construction costs associated with the Poplar Island project (GBA, 2001, 2002). A detailed summary of the construction cost associated with the proposed alignments can be found in DECE Tables 6 and 7.

The preliminary construction costs are separated by material type/size, and the different sand borrow alternatives. The materials that would be required are:

- Sand – the material required to create the "core" of the dike;
- Geotextile fabric – a synthetic material used between the sand core dike and the armor stone, and roadway stone;
- Armor stone – different size stones used to protect the dike structure from wave attack;
- Road stone - material to cover the tops of all roadway dikes for driving purposes.

Other items that are part of the island construction are spillways for water discharge, a personnel pier and a nursery planting area. The fees associated with the engineering design and other related studies associated with the island are also included.

A summary of the estimated dike construction costs, using borrow Alternative 1, for the 10 ft alignments are given below (DECE p.5-1).

Dike Alignment No.	Dike construction cost (10 ft)
1	$100 M
2	$116 M
3	$80 M
4	$61 M
5	$81 M

A summary of the estimated dike construction costs, using borrow Alternative 1, for the 20 ft dike are given below (DECE p.5-1).

Dike Alignment No.	Dike construction cost (20 ft)
1	$118 M
2	$136 M
3	$90 M
4	$74 M
5	$88 M

The total site use cost analysis for each dike alignment and dike option is composed of the following elements:

- Study cost (reconnaissance, pre-feasibility and feasibility);
- Total construction cost;
- Site development cost (dredged material management, site maintenance and site monitoring and reporting);
- Habitat development cost (plans and design, monitoring, implementation, and operation and maintenance); and
- Dredging, transport and placement cost (mobilization & demobilization, dredging, transport, and placement).

A summary of the estimated total site use costs for a 10 ft dike are given below (DECE p.5-2):

Alignment No.	Total site use cost	Total unit cost
1	$743 M	$16.37
2	$911 M	$16.56
3	$484 M	$16.48
4	$530 M	$15.80
5	$432 M	$17.29

A summary of the estimated total site use costs for a 20 ft dike are given below (DECE p.5-2):

Alignment No.	Total site use cost	Total unit cost
1	$1,016 M	$15.59
2	$1,251 M	$15.77
3	$652 M	$15.41
4	$748 M	$14.98
5	$579 M	$15.85

DECE Tables 8 to 17 detail the associated costs.

3.5 Summary of Reconnaissance Study of Environmental Conditions (ECR)

3.5.1 Habitat Description

The submerged footprint of Sharps Island is all that remains since the island's disappearance in the early 1960s (Hanks, 1975). At the present time, Sharps Island is completely submerged, and thus there are no tidal wetlands on site.

The Sharps Island historical footprint acts as an open water shallow habitat for aquatic organisms. Due to the open location and shallow water at Sharps Island, these waters respond continuously to physical effects of wind, waves, currents, weather, and tides and thus undergo extreme environmental fluctuations throughout the year. In the summer, the waters become very hot with little moderation in temperature. Historical records document extreme winter weather conditions, in which ice has formed in the vicinity of Sharps Island. Heavy rain storms also constantly change the salinity of these shallow waters. Spring rains lead to the runoff of sediment and nutrients into the Choptank River, whose waters carry these materials through the Sharps Island vicinity as they enter the mainstem Chesapeake Bay (ECR p.2-1).

Shallow waters are constantly being affected by wind and storms, which suspend sediments throughout the water column. Given its location within the Chesapeake Bay, Sharps Island is especially affected by winds from northern, northwestern, southwestern, and southern directions generating higher wave heights (AMA, 2002). Higher waves and current flow within the Chesapeake Bay, coupled by Choptank River currents, result in more enhanced current action upon the footprint of Sharps Island.

While aquatic life is present in the Sharps Island area, the lack of SAV habitat due to the effect of these physical forces upon this open water habitat limits the area's productivity in relation to other shallow water shoreline habitats in the Chesapeake Bay (ECR p.2-1).

3.5.2 Water Quality

Major environmental measures of water quality include temperature, salinity, dissolved oxygen (DO), and water clarity). These measures are described in detail in the following subsections.

3.5.2.1 Temperature

Temperature dramatically affects the rates of chemical and biochemical reactions in the water. Many biological, physical, and chemical processes are temperature dependent, including the distribution, abundance, and growth of living resources, the solubility of compounds in sea water, rates of chemical reactions, density, mixing, and current movements. Because the Bay is so shallow, its capacity to store heat over time is relatively small and water temperature varies within a narrow range each season. As a result, water temperature in the Bay fluctuates considerably on an annual basis (CBP, 2002). Surface water temperature in the vicinity of Sharps Island ranges from 1–10°C in the coldest winter months, up to 20–27°C in the warmest summer months (ECR p.3-1).

3.5.2.2 Salinity

Salinity levels directly affect the distribution and well-being of the various aquatic species living in the Bay. For example, anadromous finfish (e.g.. rockfish) spawn in fresh water with salinities close to or equal to zero parts per thousand (ppt) and live the rest of their lives in high salinity waters at sea. Oysters can live only within a narrow salinity range. Salinity also affects the density of the water which is an important factor to the mixing of oxygen rich surface waters with the oxygen depleted bottom waters.

Based on its central location within the Chesapeake Bay, and its position within the outflow of the Choptank River, the Sharps Island area is expected to have mesohaline salinity regime. Monitoring data for the Sharps Island vicinity confirms this assumption. Surface salinity in the vicinity of Sharps Island ranges from 2–12 ppt during spring runoff, and from 9–18 ppt in the fall and winter. Seasonal and tidal salinity ranges for the Sharps Island vicinity are presented as part of ECR Figure 3-1.

3.5.2.3 Water Clarity

Clear water absorbs less light than turbid water, allowing more light energy to reach primary producers like SAV and phytoplankton. Secchi depth is the depth at which a specially marked disk, when lowered into the water, is no longer visible to the naked eye. The greater the depth at which the Secchi disk disappears from view, the clearer the water. Maryland's Chesapeake Bay Water Quality Monitoring Program measurements at this location taken between 1985 and 1999 range from 1.3-1.8 meters (ECR Figure 3-2).

3.5.2.4 Dissolved Oxygen (DO)

DO is a major factor affecting the survival, distribution, and productivity of living resources in Chesapeake Bay. Low DO levels reduce available habitat and adversely impact the growth, reproduction, and survival of the Bay's fish, shellfish and bottom dwelling organisms (CBP, 2002). Much of the deep water of the Chesapeake Bay mainstem becomes anoxic during summer months and is therefore nearly devoid of animal life (Jordan et al, 1992). Data from 1985–1989 within the Chesapeake Bay Program report, Habitat Requirements for Chesapeake Bay Living Resources, indicates that the Sharps Island vicinity does not seem to have low summer DO readings (Funderburk *et al*, 1991). Maryland's Chesapeake Bay Water Quality Monitoring Program measures DO in the Outer Choptank River. DO measurement ranges in 1998–1999 range from 4.5 - 6.2 mg/L in the Summer, and 8.8 - 9.2 mg/L in the Spring (CBP, 2002). Long-term DO measurement recordings for the Sharps Island vicinity are presented in ECR Figures 3-3 and 3-4.

3.5.3 Sediment Quality

Between 1976 and 1984, the Coastal and Estuarine Geology Program collected 4,255 surficial sediment grab samples in the main portion of the Chesapeake Bay (Maryland Geologic Survey, 2002). The bottom sediments were classified according to Shepard's Ternary Classifications, based upon the proportions of sand-, silt- and clay-sized particles (Shepard, 1954). Based on this data and the Shepard's Ternary Classification, surface sediment in the Sharps Island vicinity consists of 50–100% sand mixed with silt (ECR p.3-3).

Based on data provided by the Maryland Department of Natural Resources (MDNR, 2002c), bottom composition in the proposed concept area includes mud, sand, cultch, and a mix of mud and/or sand with cultch (ECR Figure 3-6). To note, cultch is a rock and/or shell bottom. As clams and oysters metamorphose into juveniles, they search for this type of habitat.

The Geotechnical Report (Pre-Feasibility Study) for Sharps Island, Chesapeake Bay, Maryland provides boring data for the site (E2CR, 2002). Based on data collected upon the proposed foundation sediment at the Sharps Island historic footprint and the immediate vicinity, sediments at this site are mostly loose to dense clayey sands underlain by loose to dense silty sands.

Based on the above supporting sources of sediment data, the Sharps Island area is suitable to support the full suite of benthic invertebrate species expected in the Mid Chesapeake Bay (CBP, 1998), as long as water quality parameters fall within acceptable ranges suitable for aquatic life (ECR p.3-3).

3.5.4 Biological Resources

3.5.4.1 Essential Fish Habitat

The Magnuson-Stevens Conservation and Management Act of 1996 identifies and protects habitats of federally managed fish species. The determination of Essential Fish Habitat (EFH) was part of this Act. Congress broadly defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (NMFS, 2002). Availability of native forage species is the preeminent reason that the Chesapeake provides EFH for so many species. Various shrimp, small fish, and benthic invertebrates are important to the bottom feeders. Menhaden, silversides, and Bay anchovy are among the key prey species for the more pelagic predators. Based on MDNR data, the Proposed concept areas are not designated as critical finfish habitat (ECR p.4-1).

3.5.4.2 Habitat Area of Particular Concern

The only Habitat Area of Particular Concern (HAPC) in the mid Chesapeake Bay is Submerged Aquatic Vegetation (SAV); however, SAV HAPC is exclusive to juvenile Red Drum, and adult and juvenile Summer flounder (Nichols, 2002). Presently, there is no occurrence of SAV in the Sharps Island vicinity. However, the proposed concept area designs provide the proper conditions for SAV growth in protected shallow waters and for tidal marshes. Since Sharps Island lies within the distribution range for Summer flounder and Red Drum, creation of conditions of potential SAV HAPC may lead to occurrences of these species in the Sharps Island area (ECR p.4-1).

3.5.4.3 Fish

Commercial and recreational resources in the Chesapeake Bay include many valuable finfish and shellfish species. In particular, the mid-section of the Chesapeake Bay supports diverse commercial and recreational resources. Area-specific recreational fishing locations in the immediate vicinity of Sharps Island are presented in ECR Figure 4-2.

There are nine EFH species managed by NMFS. These species include Windowpane flounder (*Scophtalmus aquosos*), Bluefish (*Pomatomus saltatrix*), Atlantic Butterfish (*Peprilus triacanthus*), Summer flounder (*Paralichthys dentatus*), Black Sea Bass (*Centropristis striata*), King Mackerel (*Scomberomorus cavalla*), Spanish mackerel (*Scomberomorus maculates*), Cobia (*Rachycentron canadum*) and Red Drum (*Sciaenops occelatus*).

Of these EFH fish, Cobia, King Mackerel, Atlantic Butterfish, and Black Sea Bass do not generally occur in Maryland waters of the Bay and would not be expected in the vicinity of Sharps Island (Nichols, 2002). The occurrence of Windowpane flounder in the vicinity of Sharps Island would be rare. In addition, this species is not a recreationally or commercially important fish. Bluefish and Summer flounder may occur in general area of Sharps Island. In addition, Spanish Mackerel and Red Drum may occur as far north as the Choptank River. These four EFH species are included as species of concern for the Sharps Island vicinity (Nichols, 2002). ECR Table 4-1 details the seasonal frequency and life stage presence of these species of concern for Sharps Island.

While these species fall under the EFH classification, numerous commercial and recreational fish can be found in the Chesapeake Bay's waters. ECR Table 4-2 lists finfish species that occur or have the potential for existing in the mid Chesapeake Bay mesohaline environment near Sharps Island (CBP, 1998).

3.5.4.4 Benthos

The benthic community of the Chesapeake Bay represents an important ecological niche. While some benthic invertebrates are food for higher trophic organisms (fish, birds), some serve as an important commercial harvest. Based on the summary maps provided in *Habitat Requirements for Chesapeake Bay Living Resources* (Funderburk et al., 1991), Sharps Island and the immediate vicinity offer habitat to both macro and micro benthic invertebrates. Of the larger invertebrate species, blue crab (*Callinectes sapidus*), eastern oyster (*Crassostrea virginica*), and soft shell clam (*Mya arenaria*) are key components to the Bay's ecosystem, and the economy of Maryland (ECR p. 4-3).

Seasonal habitat distributions of blue crab vary. Males are found at their highest density in the summer and at low densities during the winter (MDNR, 2002c). Females are found at low densities in the summer months. While Sharps Island is not proximate to blue crab spawning areas at the mouth of the Chesapeake Bay, this area has the characteristics of foraging and refuge habitat for blue crabs (ECR p. 4-3).

Present-day and historic Sharps Island includes eastern oyster habitat as shown on ECR Figure 4-3. Based on this figure, natural oyster bar boundaries lie within the footprint of Sharps Island. In 1910, a delineation of natural oyster bar boundaries in the vicinity of Sharps Island was performed by the Maryland Shell Fish Commission, in cooperation with the US Coast and Geodetic Survey and US Bureau of Fisheries (NOAA. 2002). Natural oyster bars in the vicinity of Sharps Island during this survey included: Stone (3,273 acres northwest), Clay Bank (1,512 acres west), Hills Point (1,644 acres southeast), and Diamond (800 acres east) (ECR p.4-3).

The soft shell clam has a potential habitat density distribution greater than 1 clam per square meter in the Sharps Island vicinity. However, based on MDNR data (2002c), the Proposed Concept Area is designated as having a low abundance of shellfish (ECR p.4-3).

3.5.4.5 Submerged Aquatic Vegetation (SAV)

SAV is comprised of rooted flowering plants that have colonized primarily soft sediment habitats in typically protected freshwater, coastal, and estuarine habitats (Dennison et al., 1993). The well-defined linkage between water quality and SAV distribution and abundance make these communities good barometers of the health of estuarine ecosystems. SAV is important not only as an indicator of water quality, but it is also a critical nursery habitat for many estuarine species (ECR p.4-3).

SAV thrive in areas that can support their demanding specifications. Basically, the minimal light requirement of a particular SAV species determines the maximal water depth at which it can survive (Dennison et al., 1993). Typically, minimal light requirements are consistent for each species of SAV. Other factors such as water clarity also determine at what depth SAV can survive. Based on light attenuation coefficients for the mesohaline salinity regime found in the Sharps Island vicinity, only depths less than 6 feet MLLW are typically appropriate to support SAVs (ECR p.4-3).

SAVs are noted as a major factor contributing to the high productivity of the Chesapeake Bay (Dennison et al., 1993). Important SAV in the Chesapeake Bay region (all salinity regimes) include: *Zostera marina, Hydrilla verticillata, Myriophyllum, spicatum, Ruppia maritime, Heteranthera dubi, Vallisneria Americana, Zannichellia palustris, Najas guadalupensis, Potomogeton perfoliatus, Potomogeton pectinatus, Ceraphyllum demersum* and *Elodea canadensis* (CBP, 1992). Of these species, *Zostera* and *Ruppia* species are the only SAV that could potentially be present at Sharps Island (ECR p.4-3).

East of Sharps Island, the Outer Choptank River shorelines had increasing SAV distribution in the early and mid 1990s. However, the data from 1998, 1999, and 2000 indicate that SAV abundance has declined substantially from 1997 (Figure 4-4). The recorded drop in acreage for this particular region in the year 2000 is the most dramatic. Its cause may be from numerous potential sources, including severe algae blooms that impacted much of the Chesapeake Bay mesohaline areas that year (ECR p.4-3).

Numerous sources that record potential habitat for SAV species in the Chesapeake Bay fail to indicate growth in the Sharps Island vicinity (Orth et al, 1987; 1995; Funderbunk et al, 1991; CBP, 1992). As noted in Orth et al. (1987), aerial photography and MDNR boat surveys at three locations in the vicinity of Sharps Island did not confirm signs of SAV. In addition, previous accounts by Orth *et al.* (1995) using aerial photography did not indicate SAV in the Sharps Island vicinity. Figure 4-5 indicates water depths in the Sharps Island vicinity at depths that provide potential for SAV growth. Although appropriate depths do exist, there are no signs of SAV presence in the area (ECR p.4-3).

Based on these observations and bay-wide decreases in SAV abundance, the occurrence of SAV growth in the Sharps Island vicinity is not likely without the construction of protected shallow water habitat. The proposed concept area designs provide the proper conditions for submerged aquatic vegetation (SAV) growth in protected shallow waters and for tidal marshes. At the present time, water conditions experienced at the mouth of the Choptank River due to water speed and wind action prevent the occurrence of SAV growth. The formation of land at this site through dredged material placement will help reduce wave action in the vicinity of Sharps Island. The reduction of wave action in this area will create potential SAV habitat and may lead to potential SAV growth. Along with wetland and upland habitat, SAV and marsh vegetation growth can provide key habitats for many invertebrates, fish, and waterfowl that use SAV beds, tidal marshes, and shallow shoreline margins as nursery areas and for refuge (ECR p.4-4).

3.5.4.6 Birds/Wildlife

Since the island became completely submerged in the 1960s, terrestrial bird habitat has been lost. The only potential location for nesting, foraging, and nesting within the vicinity is the use of Sharps Light. The *Atlas of the Breeding Birds of Maryland and the District of Columbia* (Robbins, 1999) presents distribution maps and data on 199 species of birds that breed in Maryland. Sharps Island falls within or in close proximity of the northwest block of Quadrangle 170. Since the island is submerged, no species currently reside at this location. It is likely that waterfowl and other waterbirds inhabit the area at least occasionally (ECR p.4-4).

3.5.4.7 Rare, Threatened and Endangered Species (RTE)

MDNR *Rare, Threatened, and Endangered (RTE) Animals of Maryland* report identifies those native Maryland animals that are among the rarest and most in need of conservation efforts as elements of our State's natural diversity (MDNR, 2001). Of the RTE aquatic species on Maryland's list, sea turtle species have the potential to occur in the Sharps Island vicinity. At the April, 2002 Bay Enhancement Working Group (BEWG) meeting, NMFS stated that the Loggerhead turtle will be negatively impacted, and that the Kemps Ridley turtle may be negatively impacted in the Sharps Island vicinity (Nichols, 2002). The USFWS stated the position that both the Loggerhead and Kemps Ridley turtle species are transients to the area, and that there may be no overall impact on sea turtles (USFWS, 2002) (ECR p.4-4).

Since the island is submerged, no RTE avian species currently reside at this location. Waterbirds such as osprey and the bald eagle may potentially inhabit the area at least occasionally.

The US Fish and Wildlife Service (USFWS) noted that except for the occasional transient individuals, no federally proposed or listed endangered or threatened species are known to exist at Sharps Island. In addition, coordination with MDNR Wildlife and Heritage Service indicated that there are no records for Federal or State RTE animals or plants at Sharps Island. However, MDNR had a historical record for a Least Tern (*Sterna antillarum*) colony that used to inhabit Sharps Island. Least terns are currently listed as state threatened in Maryland, and colonies within the Chesapeake Bay Critical Area are protected (ECR p.4-4).

3.5.4.8 Commercial and Recreational Fisheries Resources

3.5.4.8.1 Finfish

Although there are no specific data for Sharps Island, the MDNR database provides information for two nearby areas. The locations of these proximate harvest areas as well as other harvest areas in the region are presented in CER Figure 5-1. Based on the regional data, the Choptank River falls within the low finfish catch range (0 to 61,100 pounds/year).

3.5.4.8.2 Blue Crabs

Based on NMFS blue crab harvesting statistics concerning the Chesapeake Bay, the number of crabs caught in the Chesapeake Bay has been dropping in the past few years. Based on information obtained from the MDNR database for blue crab caught in the Choptank River and South Central Chesapeake Bay, in general, the size of the blue crab harvest is steadily declining in the vicinity of Sharps Island. This scenario holds true for most of the Chesapeake Bay (ECR p.5-1).

3.5.4.8.3 Oysters and Soft Shell Clams

The oyster and soft shell clam industries of Maryland have shown decline within the Bay. Information obtained from MDNR show low harvest numbers for the past ten years (MDNR, 2002b). Oyster disease has limited the harvest numbers for many years.

Present day oyster bar boundaries partially cover the 1848 historical footprint of Sharps Island. In particular, Natural Oyster Bay (N.O.B.) 14-4 encompasses nearly 3,400 acres of the Island's historical footprint. However, the greater portion of this oyster bar is located to the west of the Island's historical footprint (BBL, 2002). ECR Figure 4-3 indicates the locations of both the historical oyster bars charts and Legal Natural Oyster Bar boundaries around Sharps Island, and indicates that shallow waters around Sharps Island are suitable oyster habitat.

3.5.4.8.4 Recreational Fishing and Boating

While the mid Chesapeake Bay supports numerous key recreational fishing locations, none are found within the proposed concept areas. Commonly referred to fishing locations in the Mid Chesapeake Bay are shown in ECR Figure 4-1. Larger and more commonly known recreational fishing locations within 3-4 km of Sharps Island include: the Hook (north), Devil's Hole (northwest), Stone Rock (southeast) and Diamonds (south) [MDNR, 2002c]. While the mid Chesapeake Bay supports numerous key recreational fishing locations, none of the commonly referred to fishing locations lie directly upon the historical footprint of Sharps Island or the proposed concept area. In comparison to the common fishing locations of the mid Chesapeake Bay indicated in ECR Figure 4-1, site-specific recreational fish grounds in the vicinity of the Sharps Island are presented in ECR Figure 4-2. Based on this map, the proposed concept area designs will directly affect site-specific recreational fish grounds adjacent to the west of the Sharps Island site. In addition, dredge material placement activities may potentially be deleterious to recreational fishing activities approximately 1 mile to the north and to the east of Sharps Island (ECR p.5-2).

The MDNR Fisheries Service provides recreational sport fishing enthusiasts fishing reports for the Chesapeake Bay and its major tributaries. Upon review of Middle Chesapeake Bay fishing reports, it is apparent that many finfish species may potentially be present in the vicinity, including croaker, striped Bass, white perch, catfish, hickory and American Shad. To the date of this report, available information does not indicate that artificial fishing reefs have been established in the footprint of Sharps Island (ECR p.5-2).

Correspondence with Mr. Richard Novotny, Executive Director of the Maryland Saltwater Sportfishermen's Association (Appendix C) suggests that the vicinity of Sharps Island is a traditional fishing area for both charter boat and recreational fishing. According to Mr. Novotny, Atlantic croakers, Norfolk spot, white perch, weakfish (seatrout), and rockfish are caught in or around the Sharps Island area (ECR p.5-2).

3.5.5 Commercial Fisheries Resources

Correspondence with the Natural Resources Police indicated that the Sharps Island area provides a valuable resource for commercial fisheries. It was noted that pound net fishermen catch a broad variety of fish in the area (ECR Figure 4-2). It was also noted that Sharps Island and the immediate vicinity contain productive oyster bars (ECR Figure 4-3). Drift gill net fishing occurs in the area during the striped bass gill net season. Blue crab harvesting in the area primarily consists of crab pots. Clam fisheries are not prevalent at Sharps Island with the closest being approximately 1.5 miles from the area of interest (ECR p.5-2) .

3.5.6 Historical and Cultural Resources

3.5.6.1 Native American Presence at Sharps Island

Maryland Algonquin Indian chiefdoms were present along the Middle Chesapeake Bay during early European colonization. Historically, Choptank Indians were present along the banks of the Choptank River and Sharps Island (Clark and Rountree, 1993). Early Colonists and Native Americans were in close and relatively constant contact with each other on the Eastern Shore of Maryland throughout most of the 17th and early 18th centuries. By 1725, all Choptank Indian towns had been abandoned, with the exception of Locust Neck, an Indian community located in Dorchester County. Locust Neck was the last remaining Indian town to remain along the Eastern Shore until its abolishment by the Maryland government in 1799 (ECR p.6-1).

3.5.6.2 Historical Sharps Island Documentation and Habitation

One of the earliest explorers of the Chesapeake Bay was Captain John Smith. Smith first mapped and described Sharps Island in 1608 during his first full-scale exploration of the Chesapeake Bay (Sanchez-Saavedra, 1975). During the 1600s, the Island is recorded to have had three different owners: William Claiborne, John Bateman, and Peter Sharp, its namesake (ECR p.6-1).

In the early 1800's, a farming and fishing community existed with houses, schools, a post office, and a popular resort hotel. A year after Congress declared war against Great Britain, the enemy seized Sharps Island, Tilghman and Poplar Island (Clark, 1958). By November, the British withdrew from Talbot County waters, but raids continued almost up until news of the ratification of peace negations in early 1815. Between 1850 and 1900, the island lost 80% of its land mass and by the early 1960s, the Island was reduced to a shoal; today it is only marked by Sharps Light, located in the vicinity of the original Island footprint (ECR p.6-1).

3.5.6.3 History of Sharps Island Lighthouse

The original Sharps Lighthouse was built on Sharps Island in 1838 (Turbyville, 1995). Due to encroaching waters, this lighthouse was replaced in 1866 with a new hexagonal screw-pile light and relocated 1/3 of a mile off the northern tip of the Island. In February of 1881, ice flows sheared the lighthouse from its piles and carried it for five miles down the Bay (USCG, 2002). In 1882, the lighthouse was replaced with the caisson light presently northwest of the Sharps Island 1848 historical footprint. The current lighthouse was damaged by ice in 1977, and remains on a lean (NPS, 2002). The lighthouse presently stands approximately 54 feet above mean high water. In 1982, Sharps Light was added to the National Register of Historic Places (ECR p.6-1).

3.5.7 Other Aspects

3.5.7.1 Geology

Sharps Island is located on the Atlantic Coastal Plain Physiographic Province, which traverses the majority of the eastern portion of the state. The Coastal Plain extends to the northwest up until the dividing line of the Piedmont, extending from Washington D.C. through Baltimore, Maryland and into northwestern Delaware. The footprint of Sharps Island lies 1 mile due west of a noted fault line which divides the Choptank River and extends into the Chesapeake Bay (ECR p.7-1).

3.5.7.2 Groundwater and Aquifers

Sharps Island lies above the Piney Point and Cheswold aquifers in Eastern Maryland. Of these two aquifers, it is the Piney Point aquifer that is used as a source of water in southern and eastern Maryland. Below Sharps Island, the top of the Piney Point Aquifer is approximately 175 feet below mean sea level (Williams, 1979). In the vicinity of Sharps Island, the thickness of the confining layer overlying the Piney Point aquifer has been estimated to be approximately 50 feet (ECR p.7-1).

3.5.7.3 Aesthetics and Noise

Sharps Island is located approximately 4 miles south of Tilghman Island (Talbot County) and 4 miles west of Cook Point (Dorchester County) at the mouth of the Choptank River. In comparison to Poplar Island, Sharps Island is approximately 1.3 miles further from land, and would therefore have a lesser problem regarding on-site construction lighting issues during the process of dredged material placement. Therefore, due to its given location, this site does not pose a direct aesthetic or noise issue (ECR p.7-1).

3.5.7.4 Unexploded Ordnance

Throughout the Chesapeake Bay, sediment may potentially contain unexploded ordnance (UXO) as the result of historical military and naval activities. Based on military documentation, UXO and munitions resulting from testing and training activities may be encountered in the Sharps Island vicinity. In 1943, the Federal Government acquired approximately 6.5 acres to create Sharps Island Air Force Range. Based on the estimated size of Sharps Island in 1943, it is estimated that the acquired acreage was the entire remaining exposed land. The Sharps Island Air Force Range was primarily used by military personnel from Bolling Field, Washington, D.C. as a remote location for bombardment and machine gun training (ECR p.7-1).

3.5.7.5 Navigation

Sharps Island is approximately 4.2 miles northeast of a recreational channel, located near Blackwalnut Point. A natural deep water channel, with a depth of 60 feet, is located 3.5 miles to the west of Sharps Island. In order to commence dredged material placement at the site, a local access channel would have to be dredged to reach the proposed concept area location (ECR p. 7-2).

The proposed project areas lie east of the main shipping channel in the Chesapeake Bay. The proposed environmental restoration areas range in depth from approximately 6 to 12 feet deep, which makes this area too shallow for commercial shipping. It is likely that this area is utilized by small, private vessels including fishing, recreational, and sailboats. Commercial fisherman and crab-boats also navigate through this area, although this traffic is anticipated to be light due to the shallow depths.

The Sharps Island Light is located in the vicinity of Sharps Island. Originally constructed in 1838, the lighthouse remains as an aid to navigation in the southern Chesapeake Bay. The lighthouse is currently in use today. The lighthouse is equipped with a foghorn, and a flashing white light with one red sector that can be seen from a distance of 9 miles (USCG, 2002). The proximity of Sharps Island to other navigational buoys in the mid Chesapeake Bay and Choptank River are presented in ECR Figure 4-1.

3.5.8 POTENTIAL IMPACTS

3.5.8.1 Water and Sediment Quality

Existing sediments in the project footprint would be buried and replaced with created uplands or wetlands depending on location. Impacts outside the footprint would be limited. Sediments suspended in the water column cause the water to become cloudy, or turbid, decreasing the light available for underwater Bay grasses. However, it is assumed that longer term water clarity would not be affected by the proposed activities and might be improved if tidal or subtidal vegetation are established in the area (ECR p. 8-1).

3.5.8.2 Biological Resources

The proposed concept areas would convert shallow water habitat into wetland and upland habitat. Based on the five alternative proposed concept areas, approximately 535 to 1,130 acres of tidal wetlands may be created (ECR p. 8-1).

During proposed dredged material placement, there could be localized impacts (primarily site avoidance) to finfish and shellfish. In addition, the Loggerhead turtle and Kemps Ridley sea turtle species could be forced to avoid the area during placement operations. It should be noted that marine turtles are transients in open water habitat in this portion of the Chesapeake Bay, suggesting that negative impacts, if any, would be restricted and very short-term (ECR p. 8-1).

Upon completion of this project, the creation of wetland and upland habitats will inevitably lead to a resurgence of species to the area. Fish, shellfish, and turtles (primarily the Diamondback Terrapin) would be expected to use wetlands and sheltered bottoms for nursery and forage habitat. Protected waters may also lead to SAV growth in the area. Potential SAV habitat in this area would support both benthic invertebrates and fish species. Birds will use created wetland and upland habitat for feeding, breeding and resting (ECR p. 8-1). In the past, Sharp's Island has supported breeding by the State-threatened Least Tern.

3.5.8.3 Commercial and Recreational Fisheries Resources

Recreational fishing and oyster resources are found in the Sharps Island vicinity. Based on recreational fishing grounds bordering the proposed concept area (ECR Figure 4-2), and the location of oyster restoration sites and natural oyster bar boundaries within the proposed concept area (ECR Figure 4-3), there could be localized negative impacts upon these activities (ECR p. 8-1).

3.5.8.4 Historical and Cultural Resources

Due to the current submerged condition of Sharps Island, there are no present historical and cultural concerns to note. It should be noted that none of the proposed activities pose an impact upon the Sharps Island lighthouse (ECR p. 8-1).

4.0 CONCLUSIONS

Based upon the information presented in the four studies summarized by this report, the creation of a beneficial use and habitat restoration project at the Sharps Island site would likely result in both negative and positive impacts. These impacts are as follows: 1) potential risk of localized impact to finfish (primarily Bluefish, Summer flounder, Spanish Mackerel and Red Drum) and the Loggerhead turtle and Kemps Ridley sea turtle during proposed dredged material placement; 2) negative impact upon recreational fishing grounds bordering the proposed concept area; 3) negative impact upon natural oyster bar boundaries within the proposed concept area for 4 of the 5 dike alignments considered; 4) positive environmental impacts including increased habitat for threatened and endangered species and contribution to the overall goal of the Chesapeake Bay Program by potentially increasing the area of SAV beds around the Sharps Island area; 5) more than sufficient volume of resident borrow material for dike construction; and 6) competitive placement costs for dredge material.

From an engineering perspective, the construction of Sharps Island is technically feasible. The initial cost to construct the island ranges from $ 61 M to $136 M. Total site use cost ranged from $432 M to $1,250 M (for Alignments No. 5 and No. 2 respectively). Total unit cost ranged from $14.98/cy to $17.29/cy (for Alignments No. 4 and No. 5 respectively). Alignment No.4 with the upland portion constructed to +20 ft provides the best unit cost ($14.98/cy) for the allotted storage capacity of approximately 50 mcy.

Alignment No. 5 with the upland portion constructed to +20 ft provides the best unit cost for the allotted storage capacity of 37 MCY for a site not located within the oyster bar foot print. The total site use cost for Alignment No. 5 (constructed to +20-ft) would be $579 M and the total unit cost would be $15.85/cy.

5.0 REFERENCES

Note: Each of the four Reconnaissance Reports (see Appendices A-D) contains its own reference section and should be referred to for references cited in the Consolidated Report.

APPENDIX A

COASTAL ENGINEERING RECONAISSANCE STUDY

Coastal Engineering Reconnaissance Study for Sharps Island, Maryland For Potential Beneficial Use and Habitat Restoration

Sharps Island Lighthouse, 1885 (Source: US Coast Guard)

Prepared for:
Maryland Environmental Service

Prepared by:
Andrews, Miller and Associates, Inc.
Cambridge, Md.

MPA Contract No. 500912
MPA Pin No. 600105-P
MES Contract No. 01-07-13

August 2002

EXECUTIVE SUMMARY

This reconnaissance study provides background and coastal engineering design guidance for the evaluation of the potential for Sharps Island to be used as a large-scale beneficial use of dredged material and habitat restoration site on the order of 1,000 to 2,000 acres in size. This study will include a review of existing geotechnical data and assessments utilizing available, relevant and readily obtainable data on bathymetry, topography, wind conditions, water levels, currents and sediment data with regard to the effects on dike construction at the site.

The report addresses two major needs of the project, 1) identification and evaluation of available data that can be used to describe coastal processes at the Sharps Island site, and 2) design parameters (i.e., stone size and dike elevation) of the proposed dike alignments based on the coastal processes. In addition, recommendations for additional coastal engineering analysis and modeling to optimize the dike layout have been provided.

Environmental Site Conditions

In the Sharps Island area, water depths are shallower along the east and south shorelines of the proposed preliminary dredged material placement islands, with depths ranging from –8.0 to –10.0 feet Mean Lower Low Water (MLLW). Depths along the west and north sides are deeper, ranging between –11.0 and –14.0 feet MLLW.

Design winds were developed from a 32-year data set from Baltimore-Washington International (BWI) Airport. Fastest mile wind speeds were developed for selected return periods ranging from 5 to 100 years. Design winds with a one hour duration were developed for each of the eight primary directions (N, NE, E, SE, S, SW, W, and NW).

The mean tide level is approximately 0.8 feet above MLLW and the mean tide range is approximately 1.4 feet. Based on hydrodynamic modeling predictions of storm surges within this portion of the Chesapeake Bay conducted by the Virginia Institute of Marine Science, the 50-year surge elevation is 4.6 feet above mean sea level and the 100-year surge level is 5.4 feet above mean sea level.

Using historical wind data from Baltimore-Washington International Airport, estimates of wave heights approaching from eight compass sectors were determined. The USACE computer application ACES (Automated Coastal Engineering System) was used in this analysis. Wave conditions were determined for the 5, 10, 25, 35, 50 and 100-year return periods.

Coastal Engineering Design

The method of Van der Meer (1992) was utilized for the runup analysis and dike crest height determination, for a structure with a 3:1 slope. For the 35-year project design conditions, the estimated dike height is approximately 10 ft. (MLLW) for the North and West dike sections, 12 ft. (MLLW) for the South dike section and 7 ft. (MLLW) for the East dike section. The reduced height of the eastern section is the result of lower waves from the eastern wave fetch direction.

Stone sizes determined for the dike alignments are given in the following table. Maximum wave heights in the surf zone adjacent to the dike were used for stone sizing. For the 35-year design return period, the approximate stone weight for Alignment 1 along the North, West, and South portions of the dike varies between 1.16 tons and 2.52 tons, with 0.63 tons for the eastern dike section, which is more sheltered. For Alignments 2 and 3, there is a similar range in stone weights between the North, East and South dike sections. However, the estimated stone weight for the West section of Alignments 2 and 3 is lower, 1.2 tons due to the shallower depth at the toe of the dike.

The required toe stone weights for the North and West sections of the dike are 0.7 tons and 0.3 tons for the East and South sections for Alignment 1 for 35-year return period waves with a still water elevation corresponding to MLLW. For Alignments 2 and 3, there is a similar range in stone weights between the North, East and South dike sections. However, the estimated toe stone weight for the West section of Alignments 2 and 3 is lower, 0.3 tons due to the shallower depth at the toe of the dike.

Dike outer slope armor, toe and underlayer stone sizes (W_{50} in tons) computed for 35-year return conditions for 3:1 slope.

Dike Section	Dike Layer		
	Outer Slope	Toe	Underlayer
North Dike Align. 1	2.52	0.7	0.25
West Dike Align. 1	2.52	0.7	0.25
South Dike Align. 1	1.16	0.3	0.15
East Dike Align. 1	0.63	0.3	0.08

Recommendations for Additional Coastal Engineering Analyses

In addition to the evaluation of coastal engineering design parameters for the dike, it is recommended that a study of regional tidal hydrodynamics be conducted to optimize the final dike layout and ensure hydrodynamic impacts of the dike system are minimized. This modeling effort should include an analysis of existing tidal currents around the island, tidal currents during storm events and tidal current patterns associated with alternative dike alignments.

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1.0 INTRODUCTION

1.1 Purpose and Scope

The purpose of the reconnaissance study is to provide background and coastal engineering design guidance for the evaluation of the potential for Sharps Island to be used as a large-scale beneficial use of dredged material and habitat restoration site on the order of 1,000 to 2,000 acres in size. The scope of this study includes a review of existing geotechnical data and assessments utilizing available, relevant and readily obtainable data on bathymetry, topography, wind conditions, water levels, currents, and sediment data with regard to the effects on dike construction at the site.

The report addresses two major needs of the project, 1) identification and evaluation of available data that can be used to evaluate coastal processes at the Sharps Island site, and 2) design parameters (i.e., stone size and dike elevation) of the proposed dike alignments based on the coastal processes.

To optimize the functional and structural design for the proposed beneficial use of dredged material project, an evaluation of the wind, wave, and storm surge conditions impacting the site is required. This evaluation includes a statistical analysis of local wind conditions responsible for generating waves in the study area. These "design" winds were then input to the U.S. Army Corps of Engineers ACES (Automated Coastal Engineering System) program to determine local wave growth.

The design of dike containment areas for the proposed project site is dependent on several factors including active coastal processes (e.g. local wave and tidal activity), anticipated life of the structure, and maintenance needs. To assist with the design process, an evaluation of various engineering parameters associated with local wind and wave conditions was performed. The methodology and results of these analyses are described in the following sections.

Site-specific topography/bathymetry and storm surge information was identified and used to evaluate engineering alternatives for design of the containment dikes in the Sharps Island area. Proposed structures evaluated included various dike layouts required for the proposed upland and wetland cells.

In addition to the evaluation of coastal engineering design parameters for the dikes, it is recommended that future analyses of regional tidal hydrodynamics be conducted to optimize the final dike layout and ensure hydrodynamic impacts of the dike system are minimized.

1.2 Project Description

The project consists of a preliminary study to determine the feasibility of using the Sharps Island area as a beneficial use and habitat restoration site. This preliminary assessment consists of an evaluation of existing literature and data regarding the environmental, geotechnical, coastal, and dredging engineering aspects of the site.

2.0 SITE CONDITIONS

The Sharps Island area is located in the northern section of the Chesapeake Bay, south of Tilghman Island and west of the mouth of the Choptank River, as shown in Figure 1. Typically, waves within the northern section of the Chesapeake Bay are generated by local wind conditions and are fetch-limited. Given its location, the Sharps Island area is affected by wind waves from all directions with the northwest, north, south and southwest directions generating higher wave heights. Storm tides and surge associated with tropical and extra-tropical storms result in increased wave heights in the study area. An evaluation of these coastal processes is described in the following paragraphs.

2.1 Bathymetry and Geotechnical Data

Digital hydrographic data were obtained from the National Ocean Service GEODAS (GEOphysical DAta System). This digital data includes all of the National Oceanic and Atmospheric Administration (NOAA) bathymetry utilized to generate the local navigation charts and provides detailed information for the study area.. Analysis of this data indicates that water depths are shallower along the east and south shorelines of the proposed dredged material placement island dikes, with depths ranging from –8.0 to –10.0 feet MLLW. Depths along the west and north sides are deeper, ranging between –11.0 and –14.0 feet MLLW. Table 1 shows the mean water depths adjacent to proposed Dike Alignments 1-3 along each dike reach.

The proposed preliminary Dike Alignment 1, shown in Figure 2, was developed to maximize the storage capacity of the island (2,256 acres). As shown in Figure 2, the boundaries of the Natural Oyster Bar (NOB) 14-4 essentially encompass the historic footprint of Sharps Island. Dike Alignment 1 would cover about 40 percent of NOB 14-4.

Based on limited boring data collected by E2CR, the foundation soils, except in the erosion channel areas located generally along the perimeter of Dike Alignment 1, are mostly loose to dense clayey sands underlain by loose to dense silty sands. The clayey sands underlain by silty sands are considered to be suitable for supporting proposed dikes with exterior slopes of 3H : 1V and a crest elevation of + 20 ft. MLLW.

Preliminary Dike Alignment 2 (1,531 acres), shown in Figure 3, was developed to reduce the impact on NOB 14-4. Dike Alignment 2 would cover about 15 percent of NOB 14-4. Proposed preliminary Dike Alignment 3 (1,070 acres), shown in Figure 4, was developed to eliminate the impact on NOB 14-4.

Table 1: Mean water depths adjacent to each shoreline segment for Alignments 1-3.

Alignment	East	South	West	North
1	-8.0	-8.0	-12.0	-12.0
2	-8.0	-8.0	-9.0	-12.0
3	-8.0	-8.0	-8.0	-12.0

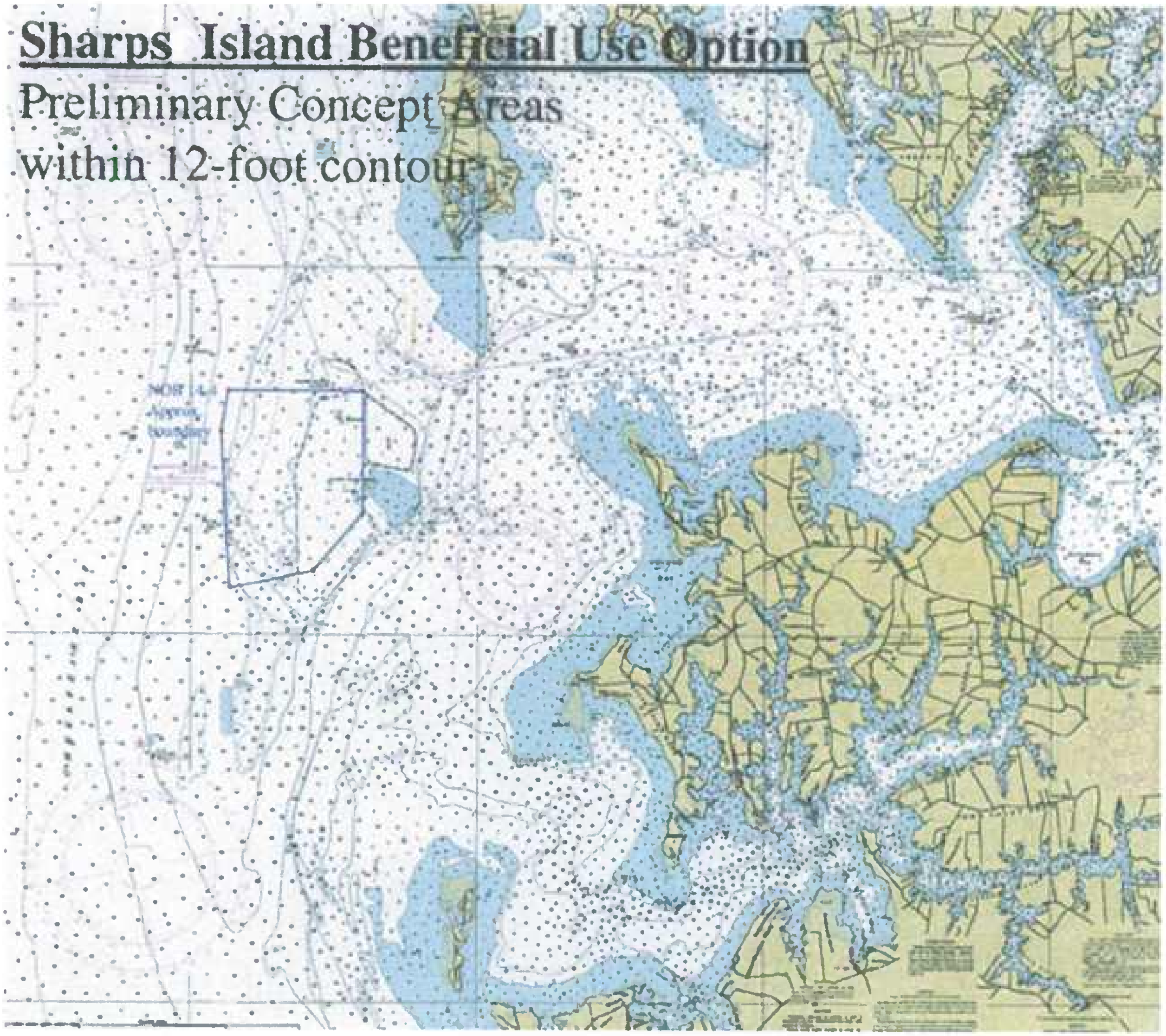

Figure 1: Location of Sharps Island

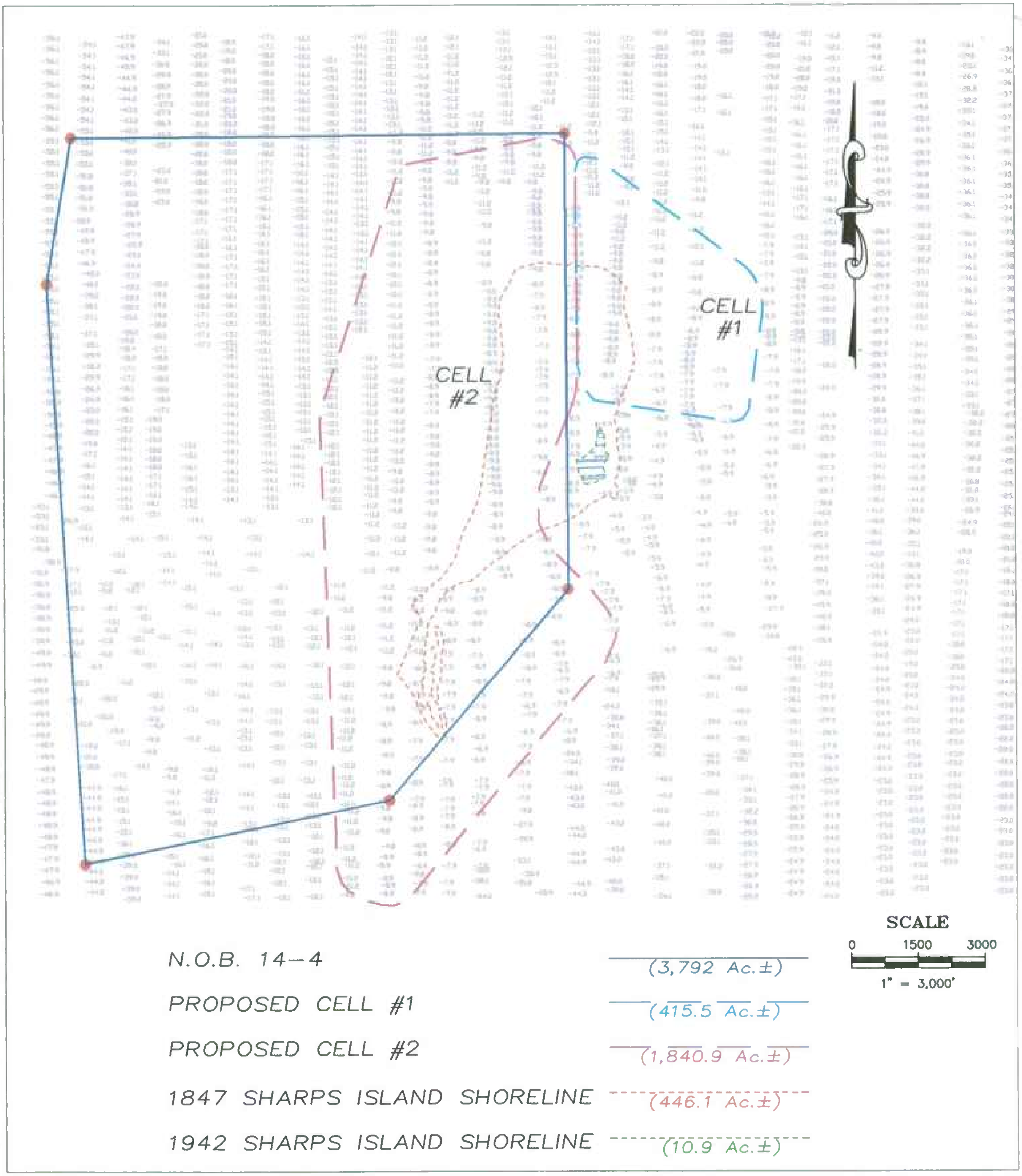

Figure 2: Preliminary Dike Alignment 1
(2,256 Acres)

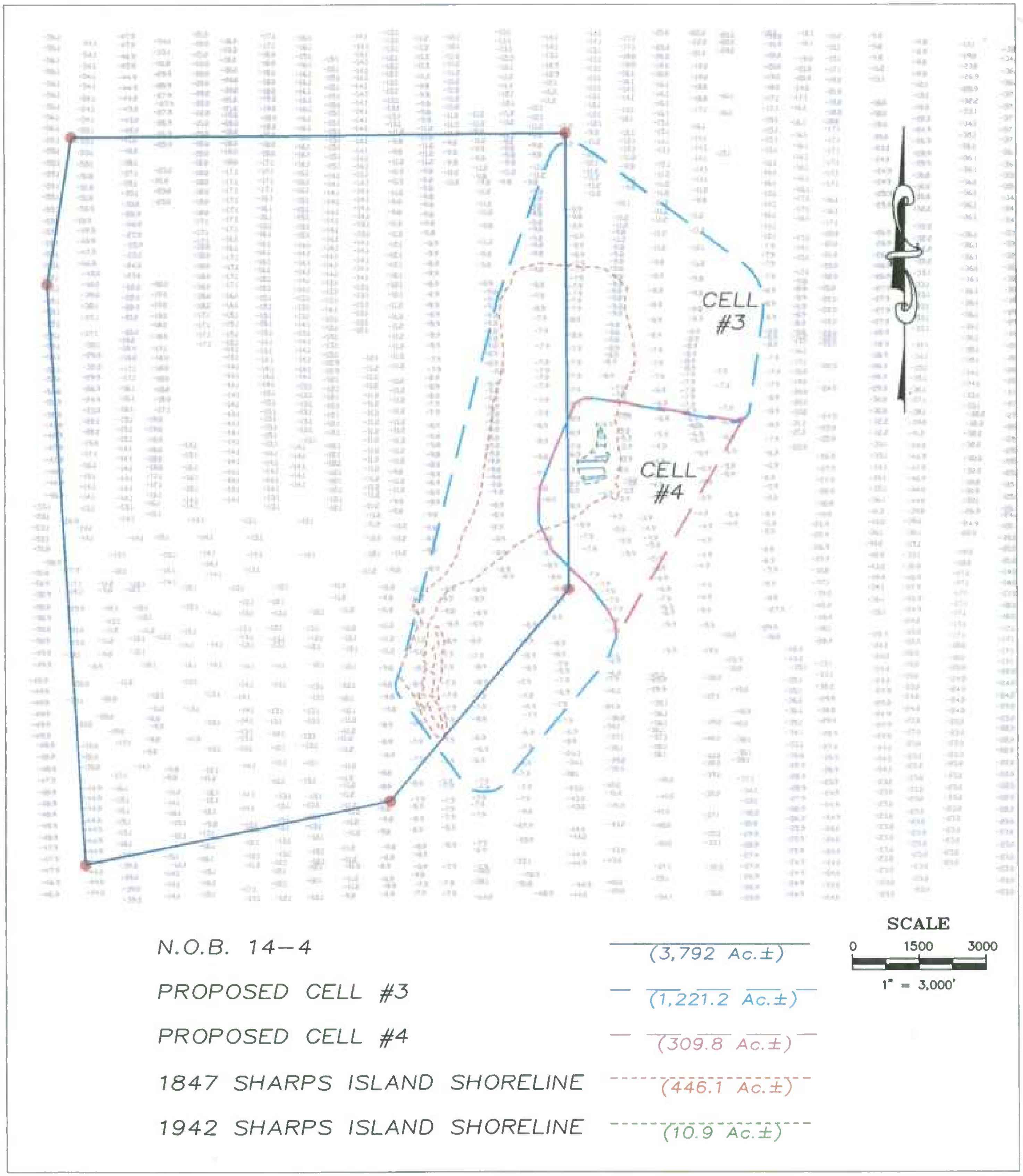

Figure 3: Preliminary Dike Alignment 2 (1,531 Acres)

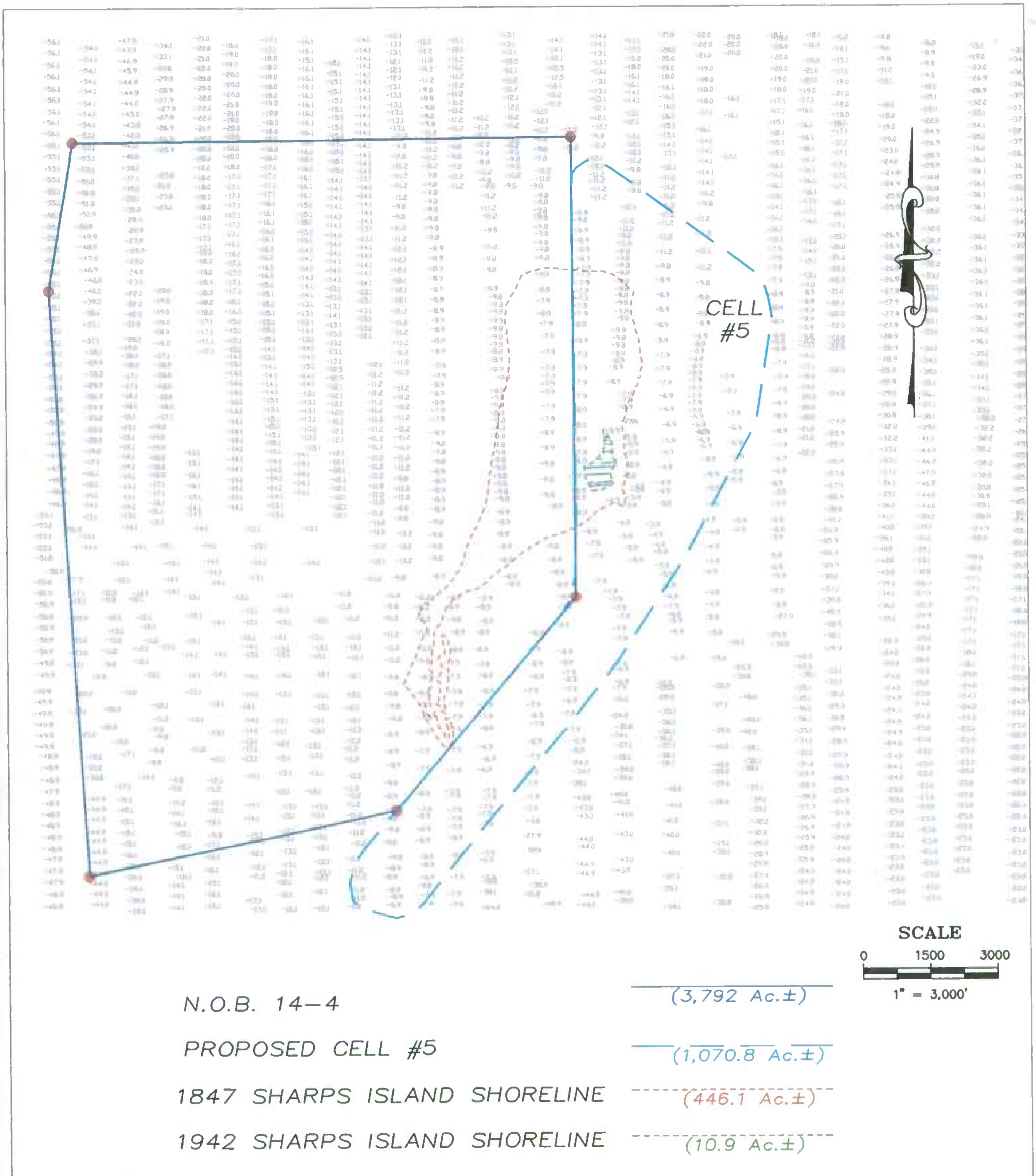

Figure 4: Preliminary Dike Alignment 3 (1,070 Acres)

2.2 Wind Conditions

To evaluate the wind conditions within the northern portion of the Chesapeake Bay, an analysis of digital wind records from Baltimore Washington International (BWI) Airport was performed. This data was obtained from the National Climatic Data Center, a division of the National Oceanic and Atmospheric Administration (NOAA), for the period between 1951 and 1982. This same data was utilized for the Coastal Engineering Investigation for Parsons Island (Moffatt & Nichol Engineers, 2001). The wind data set included the fastest mile peak daily wind gusts over this period. The data shown in Table 2 provides an annual summary of the extreme wind speeds, defined as the highest recorded wind speeds that last long enough to travel one mile during the daylong recording period. For example, a wind speed of 50 miles per hour would require a duration of 72 seconds to travel a distance of one mile. Wind speed data was utilized to develop return period relationships based on a Gumbel distribution for the eight primary directions: N, NE, E, SE, S, SW, W, and NW.

Although other wind data sources were available from stations that are located geographically closer to Sharps Island than BWI Airport, the 32-year record at BWI Airport represents the best overall wind data set for calculation of extremal wind characteristics within the northern portion of Chesapeake Bay.

To determine the return frequency of various extreme wind events, a extremal analysis of the data set was performed based on a Gumbel distribution. This technique required a curve-fit of the statistical distributions derived from the annual extreme wind speed information. Distributions were developed for each of the primary wind directions evaluated above. The results of this analysis are presented in Table 3. Since the primary purpose for developing wind conditions is to assess the local wave climate, fastest mile wind speed was converted to one-hour wind speed for input to the U.S. Army Corps of Engineers Automated Coastal Engineering System (ACES). These revised extremal wind conditions are shown in Table 4 and presented in the wind rose plot in Figure 5.

Table 2: Annual extreme wind speed for BWI Airport, 1951-1982 (Fastest Mile Wind Speed in mph)								
	Wind Direction							
Year	N	NE	E	SE	S	SW	W	NW
1951	24	41	27	34	39	29	42	46
1952	66	25	47	66	41	66	46	43
1953	20	28	22	27	34	39	47	43
1954	31	27	22	60	28	39	57	44
1955	21	43	29	28	43	53	40	43
1956	29	34	25	24	28	34	56	40
1957	29	53	35	33	33	30	46	46
1958	30	52	25	33	37	43	40	43
1959	28	26	20	27	23	38	46	43
1960	26	38	28	27	25	35	40	53
1961	45	28	28	29	24	70	41	54
1962	56	41	28	17	25	36	42	61
1963	38	32	18	34	25	28	44	60
1964	34	31	23	24	47	23	48	61
1965	36	26	28	34	36	54	44	44
1966	32	25	29	24	47	43	50	48
1967	30	29	25	39	27	46	53	43
1968	45	30	36	26	19	45	48	50
1969	28	21	20	34	26	45	45	53
1970	28	28	18	21	39	34	48	60
1971	31	45	26	18	21	41	39	58
1972	28	25	35	26	20	41	41	41
1973	40	26	26	38	26	35	49	33
1974	32	23	46	29	33	33	45	41
1975	40	26	21	24	25	38	54	45
1976	31	18	20	28	32	28	45	54
1977	32	31	19	28	26	25	49	48
1978	39	28	36	28	19	52	33	45
1979	32	25	27	36	32	32	45	47
1980	33	27	18	32	20	32	45	50
1981	24	24	19	26	23	28	41	42
1982	31	20	23	23	29	34	40	48

Data adjusted to 10-meter (32.8 feet) height.

Table 3: Design wind speeds for different return periods (Fastest Mile Wind Speed in mph)

Return Period Years	Wind Direction							
	N	NE	E	SE	S	SW	W	NW
5	40	37	32	37	36	47	50	54
10	48	44	38	45	43	56	54	59
15	52	48	41	50	47	61	56	62
20	56	52	45	55	51	67	59	65
25	59	55	47	58	54	70	60	67
30	62	57	49	61	56	73	61	68
35	64	60	51	63	58	76	62	70
40	66	62	53	65	60	78	63	71
50	69	66	55	69	63	82	64	73
100	81	76	65	82	74	97	69	81

Table 4: Design wind speeds for different return periods (One-Hour Wind Speed in mph)

Return Period Years	Wind Direction							
	N	NE	E	SE	S	SW	W	NW
5	33.4	31.1	27.2	31.1	30.3	38.6	40.9	43.3
10	39.4	36.4	31.8	37.1	35.6	45.3	43.8	47.5
25	47.5	44.6	38.6	46.8	43.8	55.5	48.2	53.3
50	54.8	51.9	44.6	54.8	50.4	64.1	51.1	57.6
100	63.4	59.8	51.9	64.1	58.4	74.7	54.8	63.4

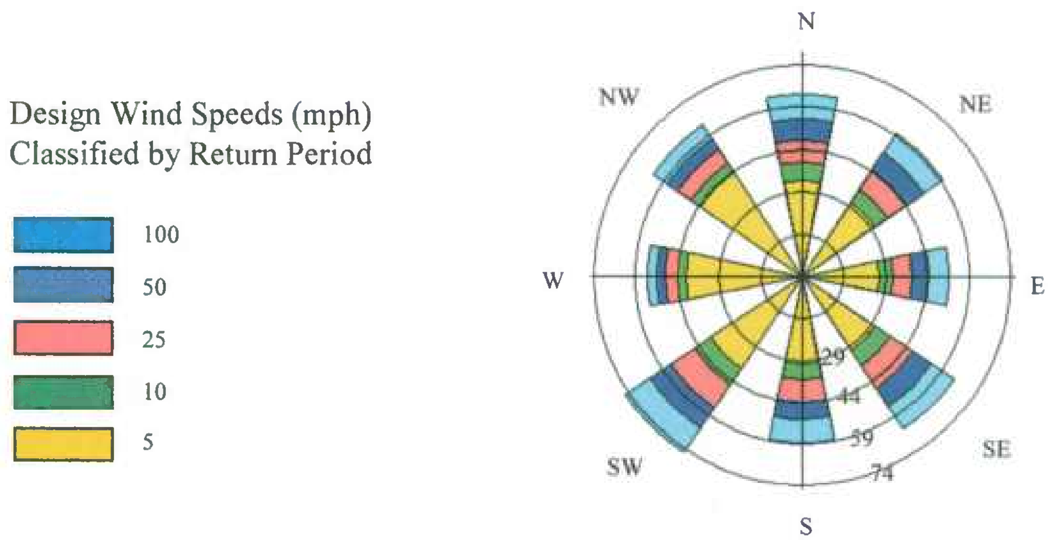

Figure 5: Rose plot of 1-hour storm wind speed from eight compass sectors, for five return periods

2.3 Astronomical Tides

Based on data from the Solomons Island NOAA Station near the mouth of the Patuxent River, tides within this portion of the Chesapeake Bay are semi-diurnal (twice daily), with a mean tide range of 1.35 feet. The mean tide level is 0.76 feet above MLLW. Table 5 shows the observed tidal characteristics at the Solomons Island NOAA Station.

In addition to water level fluctuations, astronomical tides drive currents within the Chesapeake Bay estuary. Based on the XTIDE program, maximum predicted tidal currents in the Sharps Island area are relatively weak, at about 1.0 kts or 1.7 feet/sec.

Table 5: Water elevations referred to Mean Lower Low Water (MLLW) datum at Solomons Island, MD NOAA Station

Water Level	Elevation (feet, MLLW)
Highest Water Level Observed (8/13/1955)	4.53
Mean Higher High Water (MHHW)	1.51
Mean High Water (MHW)	1.35
Mean Tide Level (MTL)	0.76
Mean Low Water (MLW)	0.17
Mean Lower Low Water (MLLW)	0.00
Lowest Observed Water Level (12/31/1962)	-3.47

2.4 Storm Surge

Due to the significant influence of storms on Chesapeake Bay water levels, design water levels for coastal engineering structures typically utilize estimates of extreme conditions. In general, two types of storms cause surge: extratropical storms (northeasters) and tropical cyclones (hurricanes and tropical storms). Extratropical storms are caused by a frontal wave disturbance originating from the middle latitudes and propagating along the U.S. East Coast in a northeasterly direction. Tropical cyclones originate in lower latitudes and have a distinct rotary circulation at the surface, with wind speeds of 39 to 73 mph for tropical storms and greater than 74 mph for hurricanes. Typically, tropical cyclones in the middle latitudes have a storm duration of less than one day as compared to the duration of extratropical storms which may be several days.

The Virginia Institute of Marine Science (VIMS) conducted a comprehensive evaluation of storm-induced water levels utilizing a numerical hydrodynamic model (Boon, et al., 1978). Return frequency curves for various surge levels were computed from combined probability distributions of tropical and extratropical storms. Based on the VIMS model, storm surge levels for selected return periods at Solomons Island, Maryland are shown in Table 6.

Table 6: Storm surge levels for selected return periods at Solomons Island, MD

Return Period (years)	Surge Level (feet, MSL)	Surge Level (feet, MLLW)
5	2.9	3.7
10	3.2	4.0
25	3.8	4.6
35	4.1	4.9
50	4.6	5.4
100	5.4	6.2

2.5 Wave Conditions

The Sharps Island area is impacted primarily by wind-waves generated in the Chesapeake Bay. To develop the wave conditions in the study area, historical wind data from Baltimore-Washington International Airport was used as input to the USACE ACES wave hindcasting program. Radially averaged fetch distances and depths for N, NE, E, SE, S, SW, W, and NW sectors, as shown in Figure 6, were determined for the Sharps Island area and are presented in Table 7. Fetch depths were determined using NOAA bathymetry data from surveys of the Chesapeake Bay. Wave conditions were determined for the 5, 10, 25, 50 and 100 year return periods. This analysis included storm surge levels above the mean fetch depth for each of the modeled return periods. Wave hindcast results are presented in Table 8 (significant wave height, H_s) and Table 9 (peak period, T_p) for the indicated return periods. This same hindcast data is presented as rose plots in Figures 7 and 8.

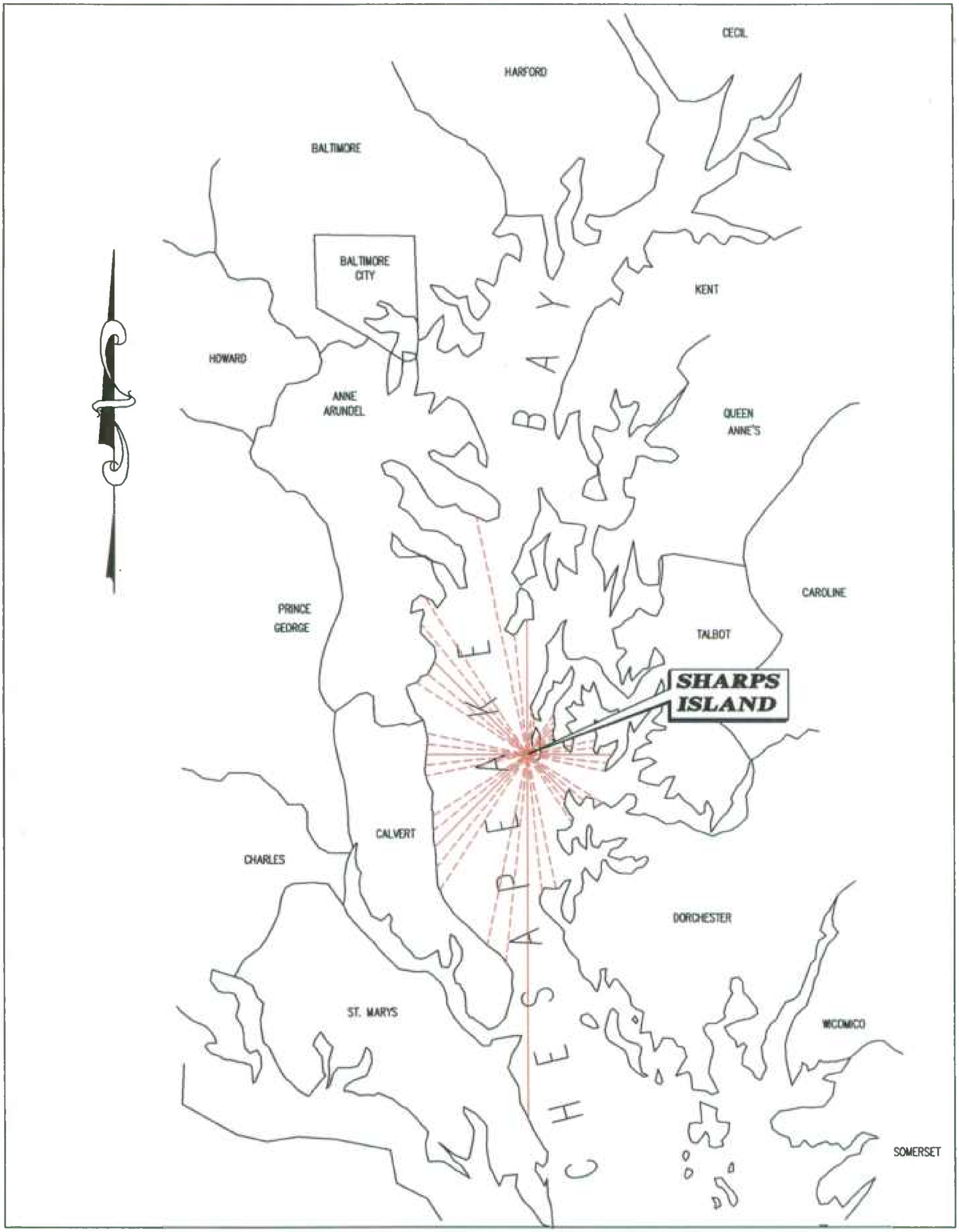

Figure 6: Fetches for wave generation in the Sharps Island area.

Table 7: Radially averaged fetch distance and depth for approaches to Sharps Island.		
Compass Sector	Mean Distance (miles)	Mean Water Depth (ft, MLLW)
N	18.6	24.8
NE	9.0	18.0
E	6.9	20.0
SE	7.6	18.0
S	38.7	47.8
SW	10.0	36.0
W	7.4	37.0
NW	12.4	39.0

Table 8: Hindcast H_S wave height (feet) determined using ACES wind-wave application.								
Return Period	S	SW	W	NW	N	NE	E	SE
5	6.4	4.8	4.0	6.0	4.7	2.9	2.3	2.7
10	7.5	5.7	4.3	6.6	5.6	3.4	2.7	3.3
25	9.2	7.2	4.8	7.6	6.7	4.2	3.4	4.2
50	10.7	8.5	5.2	8.3	7.8	5.0	4.0	5.0
100	12.4	10.1	5.6	9.2	9.0	5.9	4.7	6.0

Table 9: Hindcast T_p wave period (sec) determined using ACES wind-wave application.								
Return Period	S	SW	W	NW	N	NE	E	SE
5	5.4	4.2	3.8	4.7	4.5	3.4	3.0	3.3
10	5.8	4.5	3.9	4.8	4.8	3.6	3.2	3.5
25	6.3	4.9	4.0	5.1	5.2	3.9	3.5	3.9
50	6.7	5.1	4.1	5.3	5.5	4.2	3.7	4.1
100	7.1	5.5	4.3	5.5	5.9	4.5	4.0	4.4

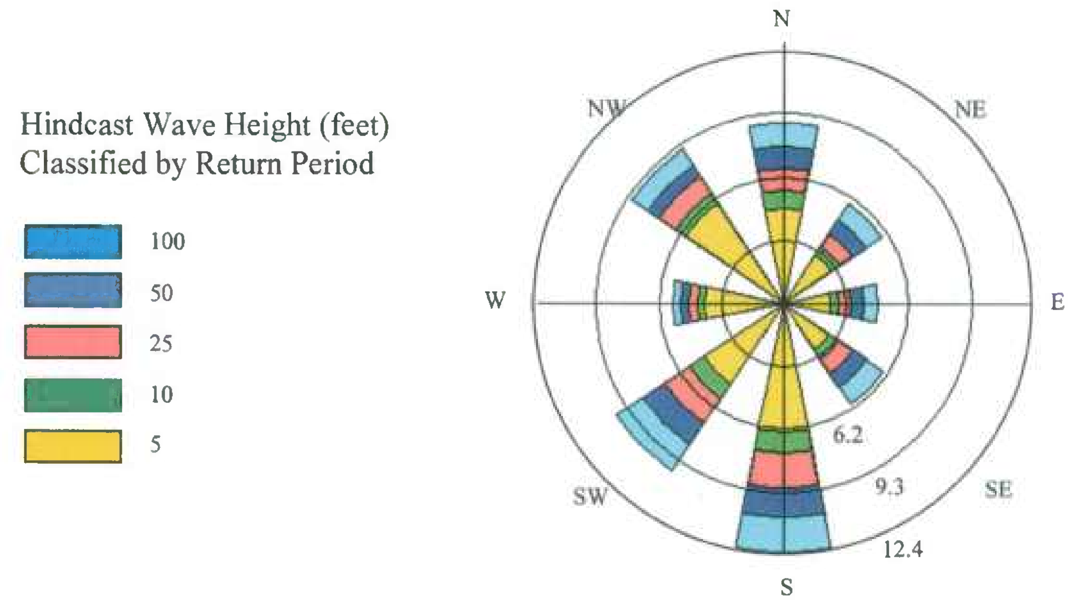

Figure 7: Rose plot of offshore storm wave heights from eight compass sectors, for five return periods.

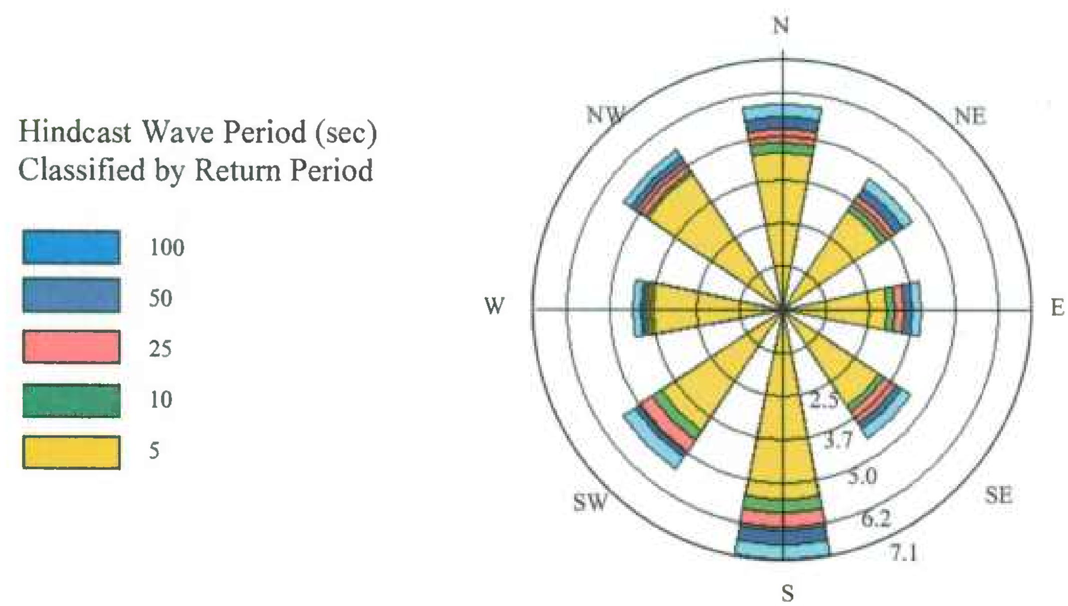

Figure 8: Rose plot of offshore storm wave peak periods from eight compass sectors, for five return periods.

For the Sharps Island site, the highest waves are estimated to approach from the South, where the 100-yr return wave height was computed to be 12.4 ft, with a peak period of 7.1 seconds. For the same southerly exposure, the 35-yr return wave height is estimated to be 10.0 ft. with a peak period of 6.4 seconds.

Random breaking wave relationships developed by Goda (1985) were used to transform the ACES hindcast results to the toe of the proposed dike at Sharps Island. This transformation is required since the ACES output represents the offshore wave conditions propagating to the site, and neglect the effects of wave breaking (energy dissipation) and shoaling (wave steepening) in the immediate vicinity of the dike structure. The following relationships from Goda (1985) were used to determine significant wave heights (H_s) and maximum wave heights (H_{max}) in the surf zone at the dike:

$$H_s \equiv H_{1/3} \begin{cases} K_s H_o' & : h/L_o \geq 0.20 \\ \min\{(\beta_o H_o' + \beta_1 h), \beta \max H_o', K_s H_o'\} & : h/L_o < 0.20 \end{cases}$$

$$H_{MAX} \equiv H_{1/250} \begin{cases} 1.8 K_s H_o' & : h/L_o \geq 0.20 \\ \min\{(\beta_o^* H_o' + \beta_1^* h), \beta_{max}^* H_o', 1.8 K_s H_o'\} & : h/L_o < 0.20 \end{cases}$$

where H_o and L_o are the deepwater wave height and wavelength, h is the bottom depth at the dike, K_s, is the shoaling coefficient, and the symbol min{a,b,c} stands for the minimum value among a, b, and c. The shoaling coefficient K_s, is expressed as:

$$K_s = \left\{ \left[1 + \frac{4\pi h L_o}{\sinh(4\pi h L_o)} \right] \tanh \frac{2\pi h}{L_o} \right\}^{-0.5}$$

The coefficients β_o, β_1 and β_{max} are formulated as follows, according to Goda (1985):

Coefficients for H_s	Coefficients for H_{max}
$\beta_o = 0.028(H_o'/L_o)^{-0.38} \exp[20 \tan^{1.5} \theta]$	$\beta_o^* = 0.052(H_o'/L_o)^{-0.38} \exp[20 \tan^{1.5} \theta]$
$\beta_1 = 0.52 \exp[4.2 \tan \theta]$	$\beta_1^* = 0.63 \exp[3.8 \tan \theta]$
$\beta_{max} = \{0.92, 0.32(H_o'/L_o)^{-0.29} \exp[2.4 \tan \theta]$	$\beta_{max}^* = \{1.65, 0.53(H_o'/L_o)^{-0.29} \exp[2.4 \tan \theta]$

Results from this analysis are presented in Tables 10 and 11 for Alignment l. These tables show the significant wave heights (H_s) and maximum wave heights (H_{max}) that are expected at the site. These results are also presented as wave rose plots in Figures 9 and 10. Generally, the offshore maximum wave height is approximately 1.8 times the significant wave height, but within the surf zone, H will approach H_S as the local bottom depth determines the maximum wave height that can be supported. For the design of the dike, the H_s wave height was used in the determination of the dike crest elevation, and H_{max} was used to determine the size of the stone used to armor the slope. The depths used in the analyses were determined using NOAA bathymetry, surge levels determined for each specified return period, and the height of mean high water above mean sea level.

Table 10: Significant wave height H_S (ft) at dike toe for Alignment 1, determined using Goda's 1985 formulas for wave height estimation within the surf zone.

Return Period	S	SW	W	NW	N	NE	E	SE
5	6.9	4.4	3.7	5.5	4.4	2.7	2.1	2.5
10	7.1	5.3	4.0	6.1	5.1	3.2	2.5	3.0
25	7.6	6.6	4.4	7.0	6.2	3.9	3.1	3.9
35	7.9	7.2	4.6	7.3	6.7	4.2	3.4	4.2
50	8.3	7.8	4.8	7.6	7.1	4.6	3.7	4.6
100	9.0	9.3	5.2	8.5	8.3	5.4	4.4	5.5

Table 11: Maximum wave height H_{max} (ft) at dike toe for Alignment 1, determined using Goda's 1985 formulas for wave height estimation within the surf zone.

Return Period	S	SW	W	NW	N	NE	E	SE
5	8.7	10.6	6.6	10.8	7.8	4.8	3.8	4.5
10	9.1	10.9	7.1	11.1	9.2	5.6	4.5	5.4
25	9.7	11.5	8.0	11.6	11.1	7.0	5.6	7.0
35	10.2	11.9	8.3	12.0	12.0	7.6	6.1	7.6
50	10.7	12.4	8.6	12.4	12.8	8.3	6.6	8.3
100	11.5	13.2	9.3	13.1	14.8	9.7	7.8	9.9

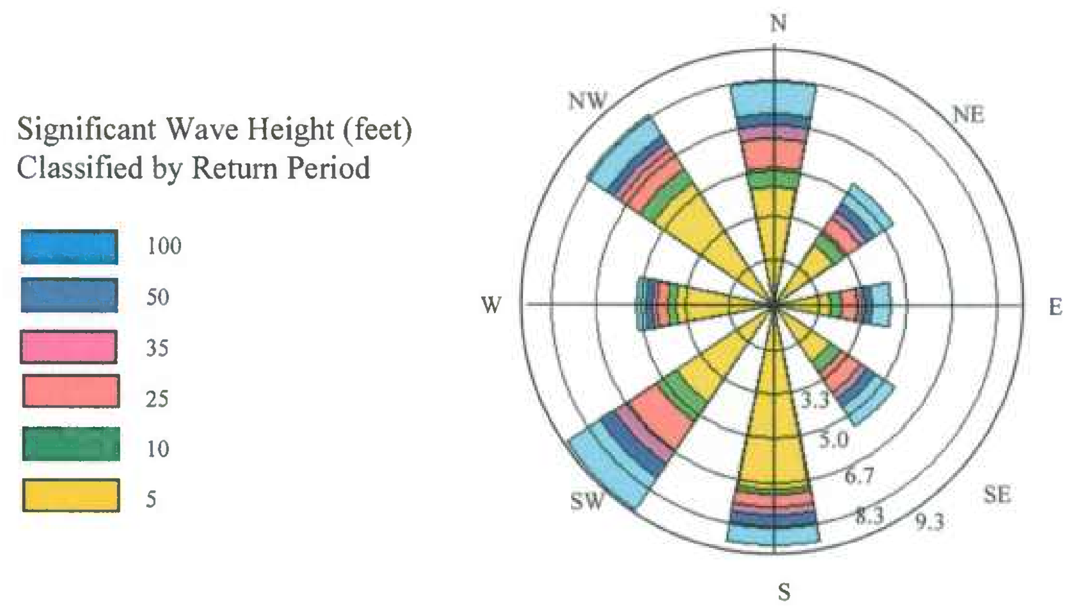

Figure 9: Rose plot of significant storm wave heights for proposed Dike Alignment 1.

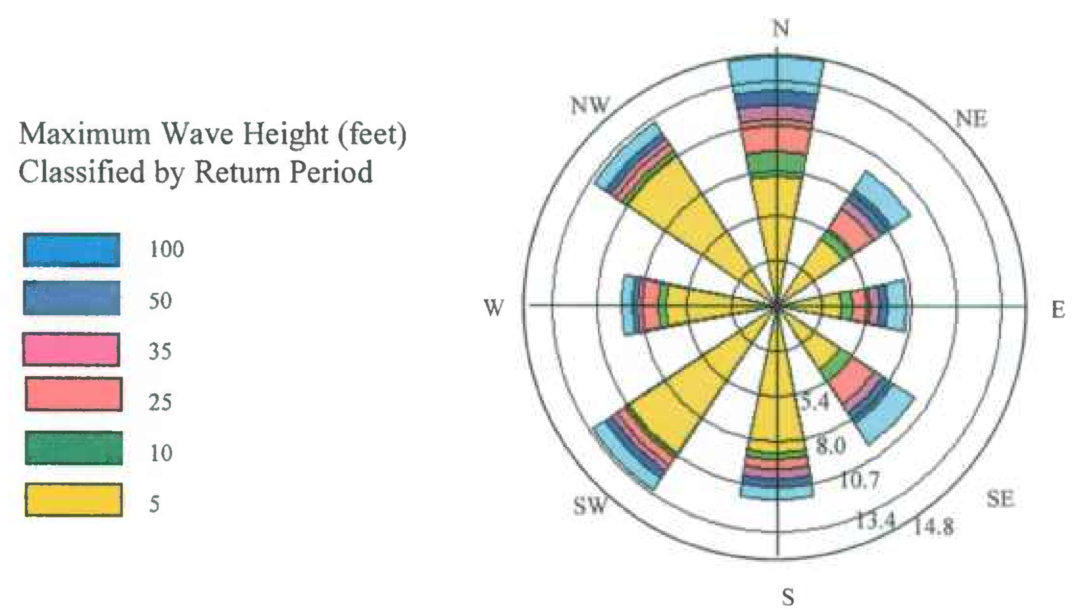

Figure 10: Rose plot of maximum storm wave heights for proposed Dike Alignment 1.

3.0 DIKE CONSTRUCTION

As outlined in the previous reports for Poplar (GBA, 1995) and Parsons Islands (Moffatt & Nichol Engineers, 2001), the primary components of a dredged material containment site protection dike include:

- Toe Protection
- Berm (if included)
- Upper Slope
- Dike Crest and Roadway
- Dike Core

The dike layouts developed for this preliminary study for Sharps Island incorporate a dike core of sand, an outer slope comprised of a double layer of armor stones to protect the core, an additional layer of toe protection at the outside base of the dike, and a dike crest which is provided with a crushed stone roadway.

3.1 Dike Design Values

Per typical design procedures, dike designs depend upon wave and tidal hydrodynamic conditions at the site for an appropriate return period event. Typical coastal projects for the Corps of Engineers are designed at the 50-year to 100-year return period design level. However, based on similar analyses for Poplar (GBA, 1995) and Parsons Islands (Moffatt & Nichol Engineers (2001), a 35-year return period for winds and storm surge elevations was chosen for those sites as the design return period to optimize the dike design. Accordingly, for this conceptual design study, the 35-year return period for winds and storm surge elevations is used as the design return period. Dike crest elevations and stone sizes are presented also for the 5-, 10-, 25-, 50-, and 100 year return conditions for comparison.

3.2 Dike Crest Height

The primary functions of the proposed dike enclosure are to provide a dredged material placement area for the hydraulic placement of suitable dredged sediments and to protect the dredge fill from wave and tidal action. Given the combination of waves and surge, it is probable that some amount of water will overtop the crest during the course of a severe storm event. From a functional design perspective, the final dike crest elevation must be selected in accordance with an allowable overtopping rate of water, i.e., the lower the acceptable overtopping rate, the higher the design dike crest. For this design study, consideration must be given to limiting the overtopping rate to a value that would maintain the structural integrity of the dike, but still permit a reasonable rate of overtopping in order to reduce the height and cost of the structure.

For this design, the method used to determine the dike crest elevation presented by Van der Meer (1992) is used based on the computed 2% wave runup for a seawall or dike. This method has been outlined previously in the preliminary design study for Parsons Island (Moffatt & Nichol Engineers, 2001). Based on a comparison of wave runup on smooth and rock slopes, Van der Meer (1992) developed the following relationship for determining the 2% runup elevation:

$$\frac{Ru_{2\%}}{H_s} = 0.83\xi_p \qquad \text{for} \quad 0.5 < \xi_p < 2$$

where, $Ru_{2\%}$ is the runup level exceeded by 2% of the runup heights; H_s is the significant wave height at the toe of the dike and ξ_p is the surf similarity parameter. The surf similarity parameter is a function of Hs (significant wave height), T_p (peak period) and slope angle (a) of the structure.

Finally, the dike crest elevation, R_c (the height of the structure above the design still water level) required for a particular overtopping discharge rate (q) is determined using the following relationship, developed by Van der Meer (1992):

$$\frac{q}{\sqrt{gH_s^3}} = 8x10^{-5} \exp\left[3.1\frac{R_{u2\%} - R_c}{H_s}\right]$$

The values of H_s as shown in Tables 10 were used for this analysis with the side slope of the dike set at 3:1 and a toe berm with a 10 ft crest width. For the purpose of determining the dike crest elevation, wave conditions from the south, northwest, and northeast were selected, as they represented the largest offshore wave conditions approaching the dike sections. Since wave conditions vary around the island, dike elevations and armor stone sizes were evaluated for four sections as shown in Figure 11. The southern wave condition was used for the South dike section, the northwestern wave condition was used for the North and West dike sections, and finally the northeast wave condition was used to size the East section of the dike.

For this application, an allowable overtopping rate of 5 L/sec-meter was used based on the previous studies of Parsons and Poplar Islands. As stated previously, dike crest elevation is dependent on the allowable overtopping rate of water, i.e., consideration must be given to limiting the overtopping rate to a value that would maintain the structural integrity of the dike, but still permit a reasonable rate of overtopping in order to reduce the height and cost of the structure. It is assumed that the dike at Sharps Island will be constructed with a compacted roadway surface at the crest following the Poplar Island example, which will provide protection similar to a vegetated crest.

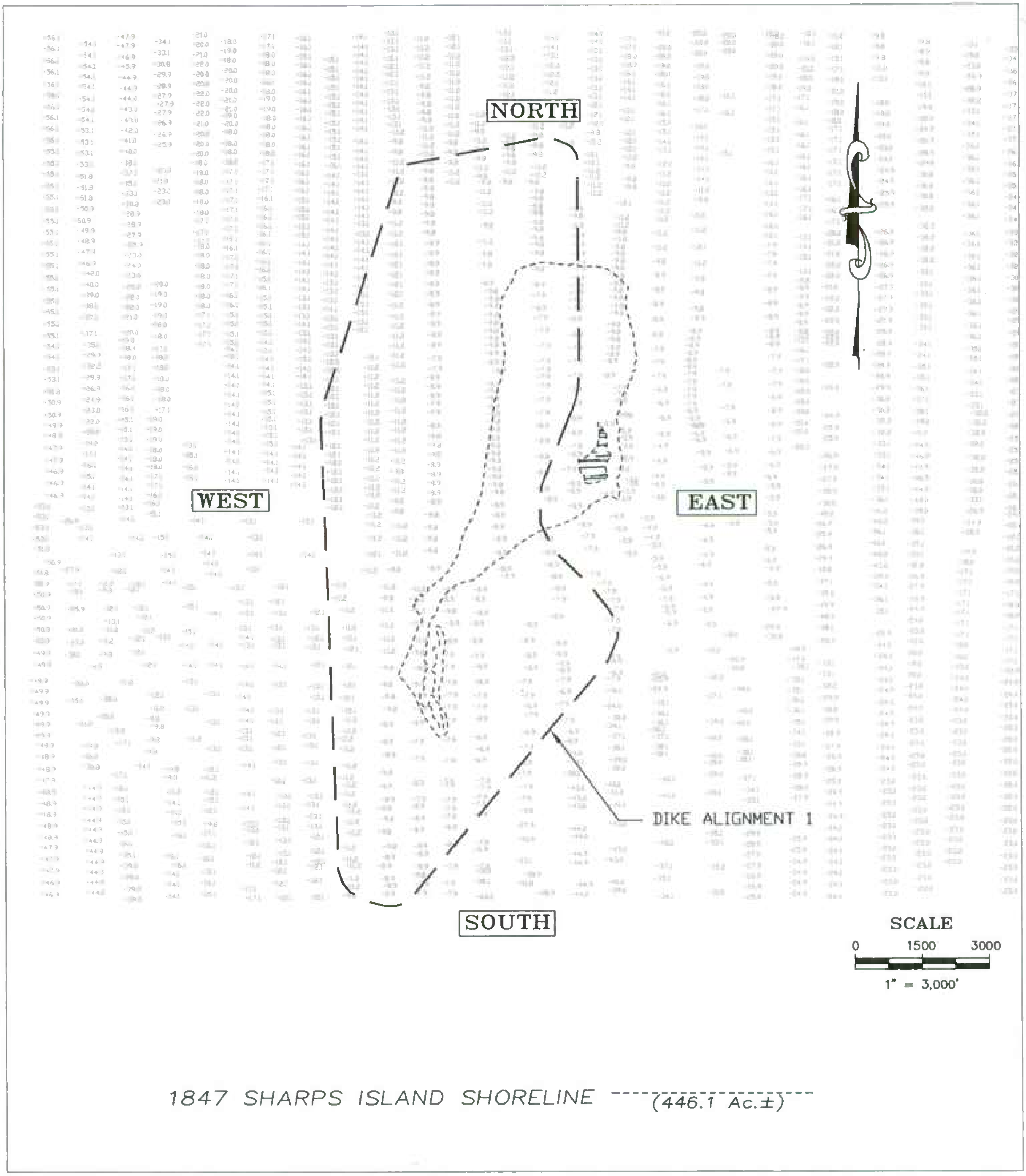

Figure 11: South, West, North and East dike sections used to determine dike elevations and armor stone sizes.

Computed dike heights are presented in Table 12 for four dike exposures (North, West, South, and East) for proposed Alignment 1. For the 35-year project design conditions, the estimated dike height is approximately 10 ft. (MLLW) for the North and West dike sections, 12 ft. (MLLW) for the South dike section and 7 ft. (MLLW) for the East dike section. The reduced height of the eastern section is the result of lower waves from the eastern wave fetch direction.

Table 12: Dike crest elevations (ft, MLLW) computed for various return conditions for 3:1 dike slope.

Dike Section	Return Period (years)					
	5	10	25	35	50	100
North Dike Align. 1	6.5	7.3	8.7	9.4	10.4	12.2
West Dike Align. 1	6.5	7.3	8.7	9.4	10.4	12.2
South Dike Align. 1	8.2	9.3	10.9	12.0	13.3	15.3
East Dike Align. 1	4.2	4.8	5.9	6.6	7.6	9.1

3.3 Armor Stone Sizing

As discussed in previous reports, several methods have been developed to determine armor stone size requirements for dikes and revetments. Similar to the previous studies for Parsons and Poplar Islands, the method of Van der Meer (1988) was utilized in this study. The H_{max} wave heights presented in Table 11 were used in this analysis as recommended by Van der Meer. The stones were sized for a double armor layer with a 0.1 permeability factor, 3:1 slope, and a structural damage level of 2 (corresponding to 0-5% allowable damage). The number of waves in the storm was set to 7000, as in GBA (1995), and as recommended by the USACE (1995). As in the dike crest determination, for the purpose of stone sizing, wave conditions from the south, northwest, and northeast were selected, as they represented the largest offshore wave conditions approaching the dike. The southern wave condition was used for the South dike section, the northwestern wave condition was used for the North and West dike sections, and finally the northeast wave condition was used to size the East section of the dike. Stone weights and sizes for the evaluated return periods are presented in Tables 13 and 14, respectively.

Table 13: Dike outer slope armor stone weights (W_{50} in tons) computed for various return conditions for 3:1 slope.

Dike Section	Return Period (years)					
	5	10	25	35	50	100
North Dike Align. 1	1.75	1.93	2.26	2.52	2.80	3.37
West Dike Align. 1	1.75	1.93	2.26	2.52	2.80	3.37
South Dike Align. 1	0.86	0.91	1.04	1.16	1.34	1.62
East Dike Align. 1	0.14	0.24	0.47	0.63	0.80	1.31

Table 14: Dike outer slope armor stone sizes (D_{50} in feet) computed for various return conditions for 3:1 slope.						
Dike Section	**Return Period (years)**					
	5	10	25	35	50	100
North Dike Align. 1	2.8	2.9	3.0	3.1	3.2	3.4
West Dike Align. 1	2.8	2.9	3.0	3.1	3.2	3.4
South Dike Align. 1	2.2	2.2	2.3	2.4	2.5	2.7
East Dike Align. 1	1.2	1.4	1.8	2.0	2.1	2.5

For the 35-year design return period, the approximate stone weight (and average dimension) for Alignment 1 along the North, West, and South portions of the dike varies between 1.16 tons (2.4 ft.) and 2.52 tons (3.1 ft.), with 0.63 tons (2.0 ft.)for the eastern dike section, which is more sheltered. For Alignments 2 and 3, there is a similar range in stone weights between the North, East and South dike sections. However, the estimated stone weight for the West section of Alignments 2 and 3 is lower, 1.2 tons (2.4 ft.) due to the shallower depth at the toe of the dike.

3.4 Toe Protection and Underlayer

Toe stone sizes were computed based on the MLLW level condition. Waves were evaluated without including storm surge since the hydrodynamic forces on the dike toe would be greatest when waves are directly plunging on the toe. From this analysis, the required stone weights for the North and West sections of the dike are 0.8 tons and 0.3 tons for the East and South sections for Alignment 1 for 35-year return period waves with a still water elevation corresponding to MLLW. For Alignments 2 and 3, there is a similar range in stone weights between the North, East and South dike sections. However, the estimated toe stone weight of the West section of Alignments 2 and 3 is lower, 0.3 tons due to the shallower depth at the toe of the dike.

An underlayer of finer sized stone is included as part of a dike design based on the USACE recommendation that the underlayer be composed of stones within the range of 0.07 to 0.10 times the weight of the overlying armor to ensure surface interlocking with the armor stones which enhances the stability of the armor layer.

3.5 Dike Cross-sections

Typical cross-sections for Alignments 1 - 3 are shown in Figure 12 and Figure 13. The typical sections are identified by 1N, 1E, 1S, 1W, etc., where 1 identifies the dike alignment (1-3) and N, E, S, W identifies the dike section location. The dimensions of the dike reflect the stones sized for a 35-year design life, and a 3:1 outer slope. The structure core is constructed using sand, and is separated from the overlying armors and underlayers by an additional layer of geotextile fabric. A 20 ft wide, 8-inch thick crushed stone roadway is provided at the crest of the dike.

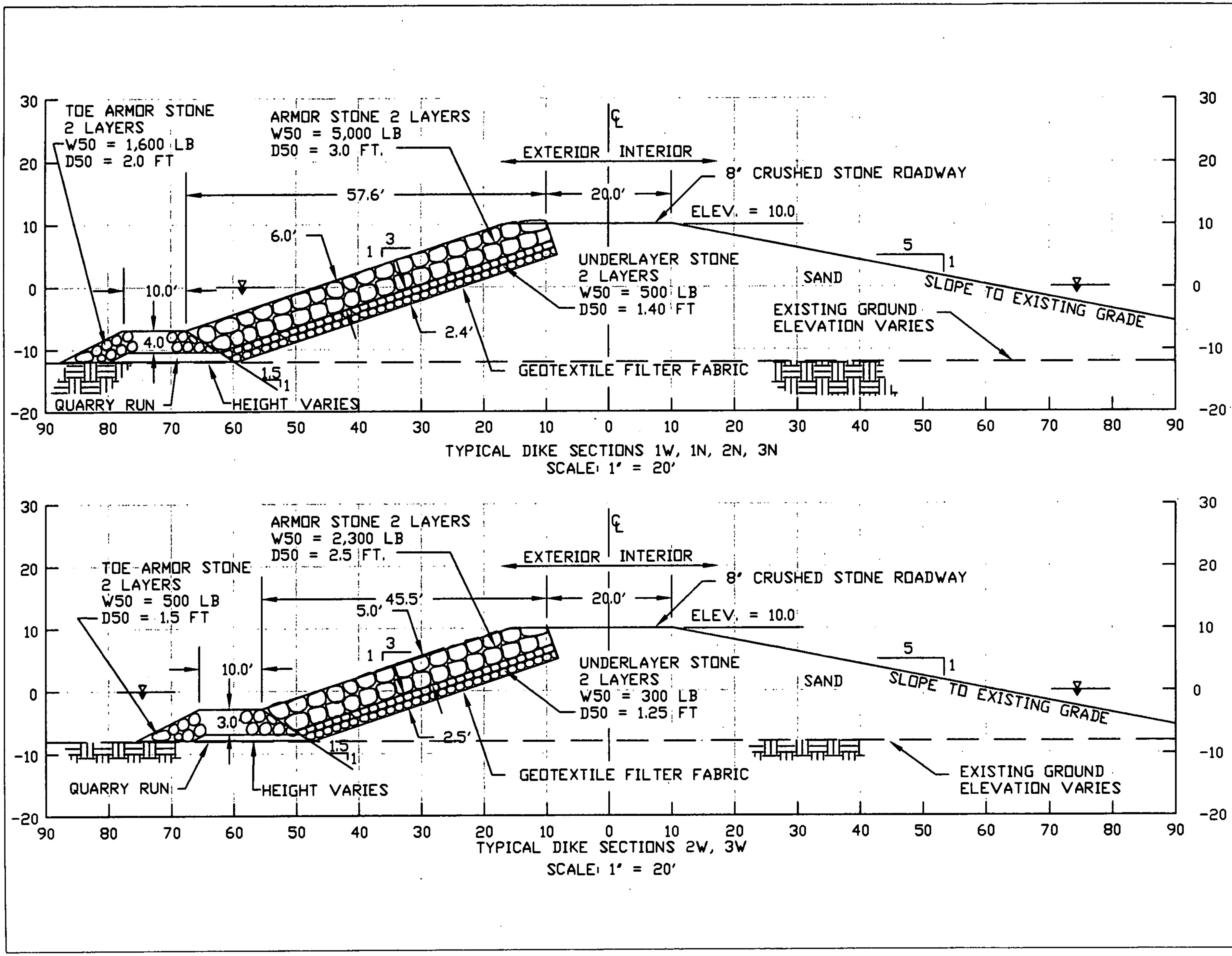

Figure 12: Preliminary Dike Alignment Sections

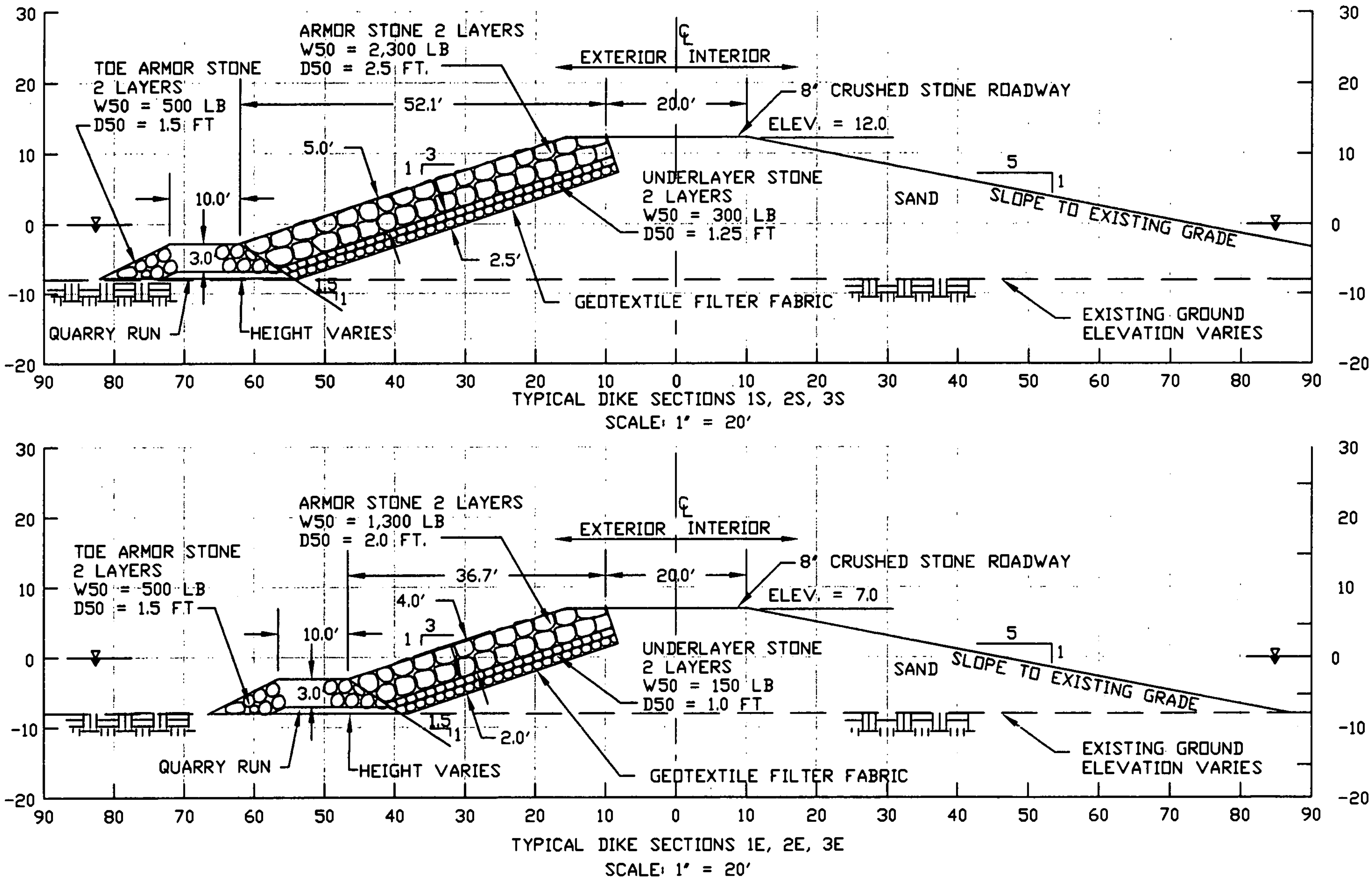

Figure 13: Preliminary Dike Alignment Sections

4.0 CONCLUSIONS AND RECOMMENDATIONS

The Coastal Engineering Reconnaissance Study identifies existing data sources and provides preliminary coastal engineering analyses for the Sharps Island site. To optimize the design of the dredged material containment dike, an evaluation of local wind, wave, and storm surge conditions impacting the site was conducted. Based on this evaluation, preliminary dike heights and armor stone sizes were determined for the 35-year design level consistent with previous studies for Poplar Island and Parsons Island.

For the 35-year project design conditions for the dredged material containment dikes, the estimated height of the dikes with a 3:1 slope is approximately 10 ft. (MLLW) for the North and West dike sections, 12 ft. (MLLW) for the South dike section and 7 ft. (MLLW) for the East dike section. The reduced height of the eastern section is the result of lower waves from the eastern wave fetch direction.

For the 35-year design return period, the approximate stone weight for Alignment 1 along the North, West, and South portions of the dike varies between 1.16 tons and 2.52 tons, with 0.63 tons for the eastern dike section, which is more sheltered. For Alignments 2 and 3, there is a similar range in stone weights between the North, East and South dike sections. However, the estimated stone weight of Alignments 2 and 3 for the West section is lower, 1.2 tons due to the shallower depth at the toe of the dike.

The required toe stone weights for the North and West sections of the dike are 0.7 tons and 0.3 tons for the East and South sections for Alignment l for 35-year return period waves with a still water elevation corresponding to MLLW. For Alignments 2 and 3, there is a similar range in stone weights between the North, East and South dike sections. However, the estimated toe stone weight of Alignments 2 and 3 for the West section is lower, 0.3 tons due to the shallower depth at the toe of the dike.

In addition to the evaluation of coastal engineering design parameters for the dike, it is recommended that a study of the regional tidal hydrodynamics be conducted to optimize the final dike layout and ensure hydrodynamic impacts of the dike system are minimized. This modeling effort should include an analysis of existing tidal currents around the island, for both normal and storm conditions, as well as tidal current patterns associated with alternative dike alignments.

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APPENDIX B

DREDGING ENGINEERING AND COST ESTIMATE

REPORT

Reconnaissance Study of Dredging Engineering and Cost Estimate for Habitat Restoration at Sharps Island

Prepared for:
Maryland Environmental Service
Under Contract to:
Andrews, Miller and Associates, Inc.
Cambridge, MD

September 2002

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engineers & scientists

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Executive Summary

This report summarizes the findings of a reconnaissance study conducted by Blasland, Bouck and Lee, Inc. (BBL) to examine the feasibility of using Sharps Island as a dredged material containment facility. The study was contracted by Maryland Environmental Service (MES), [under sponsorship by the Maryland Port Administration (MPA)] to Andrews Miller Associates (AMA). BBL was tasked with evaluating the dredging engineering aspects of the study, under a subcontract to AMA.

The historical Sharps Island footprint is being considered for possible creation of wetland and upland island habitat. The original island completely disappeared in the early 1960s, possibly due to a variety of physical and environmental factors (Hanks, 1975). Sharps Island is located approximately four miles south of Tilghman Island (Talbot County) and four miles west of Cook Point (Dorchester County) at the mouth of the Choptank River. Figure 1 presents the location of Sharps Island.

The proposed project would restore Sharps Island using dredged material from the Port of Baltimore and create upland and wetland habitats (on a 50%-50% basis by area). As part of our study, five potential dike alignments were examined, with dike heights varying from 7-10 feet (ft) (for the wetland cells) to 10-20 ft (for the upland cells). The site areas considered varied from 1,070 to 2,260 acres, with corresponding site capacities of 25 to 55 million cubic yards (mcy) for the 10-ft dike, and 37 to 79 mcy for the 20-ft dike, respectively.

Based on our review of available data, the construction of Sharps Island is technically feasible. Total site use cost for each dike alignment and dike option is composed of study cost, total construction cost, site development cost, dredging, transport and placement cost, and habitat development cost. Total site use costs ranged from \$432 million (M) to \$1,250 M (for Alignments no. 5 and no. 2 respectively). Total unit costs ranged from \$14.98/per cubic yard (cy) to \$17.29/cy (for Alignments no. 4 and no. 5 respectively). Alignment 4 with the upland portion constructed to +20 ft provides the best unit cost (\$14.98/cy) for the allotted storage capacity of approximately 50 mcy.

1. Project Background

MES, under sponsorship by the MPA, is examining potential sites throughout the Chesapeake Bay region to determine if they are suitable candidates for use as dredged material placement facilities. Several of the sites selected for this type of investigation are islands that have decreased significantly in size due to prolonged wave action or gradual sea level rise. Also, shorelines that have eroded over time due to similar environmental factors are considered for potential nourishment/beneficial use of dredged material.

The historical Sharps Island footprint is under consideration for possible creation of a wetland and upland island habitat. The original island completely disappeared in the early 1960s, possibly due to a variety of physical and environmental factors (Hanks, 1975). Sharps Island is located approximately 4 miles south of Tilghman Island (Talbot County) and 4 miles west of Cook Point (Dorchester County) at the mouth of the Choptank River. Figure 1 presents the location of Sharps Island.

MES has retained Andrews Miller and Associates (AMA) to conduct a reconnaissance study examining the feasibility of Sharps Island to be used as a large scale dredged material disposal facility and habitat restoration site. The proposed project is on the order of 1,000 to 2,000 acres in size. AMA has contracted BBL to conduct evaluations and prepare the dredging engineering and environmental reconnaissance reports for the Sharps Island project. This document summarizes the findings of the dredging engineering reconnaissance study.

2. Project Objectives

For the dredging engineering portion of the study, BBL's role is to provide an engineering assessment of the feasibility of constructing a dredged material containment facility at the Sharps Island location. Specifically, BBL's tasks (in relation to dredging) are as follows:

- Review the Geotechnical Report prepared by Engineering, Construction, Consulting and Remediation (E2CR, 2002) to assist in determining the sand borrow options. The method of excavation, transport and dike section placement will be reviewed.

- Examine five potential dike alignments to create a containment facility that will encompass 1,000 to 2,000 acre facility, capable of receiving 40 to 80 million cubic yards of dredged material over the life of the project. The footprint will be split into two equal portions, 50% uplands and 50% wetlands. The upland dikes will be reviewed for two different final elevations, +10 ft and +20 ft. The wetland portion of the dikes will be either +7 ft or +10 ft.

- Review the Coastal Engineering Reconnaissance report prepared by AMA (2002) to determine the dike height and the size of stone that will be used for the revetment structure. The investigation will also examine the existing bathymetry, topography, wind conditions, water levels, currents and sediment data with regard to the effects on the dike construction at the site.

- Estimates of neat quantities of material will be made for the following:
  - Dike fill material.
  - Revetment stones (quarry run, toe armor, underlayer stone and slope armor stone).
  - Stone for roadway construction.
  - Geotextile for revetment and roadway construction.
  - Number of spillways required for effluent discharge to the bay and interior island spillways.
  - Unsuitable foundation material to be removed and replaced with clean fill.

  The dike construction materials, areas and volumes, will be estimated from the information provided from the report prepared by AMA, (2002). The unsuitable foundation material quantities will be estimated from the geotechnical report prepared by E2CR, (2002).

- A cost estimate will be made to determine the costs associated with dredging material from the Baltimore Harbor approach channels east of the North Point-Rock Point line, and for transport and placement at the proposed facility. The estimate will also include the following: planning and design of the facility, habitat monitoring during the life of the project, planning and construction of wetlands, planting the wetlands and operations and maintenance of the facility. The cost for constructing the dike will be examined for two different methods. The first method will be to hydraulically pump suitable dike construction material directly into the dike template and the second will be to hydraulically stockpile material in a suitable location and mechanically haul and place the material in the dike template.

3. Site Characteristics

3.1 Site Characteristics

The Sharps Island light house marks the location of the original island, which was recorded in the early 1800's to be approximately 900 acres. All that remains of Sharps Island is the functional light house, which is located in Talbot County, Maryland. The site is located at the mouth of the Choptank River. Portions of all of the proposed alignments are located within Natural Oyster Bay (NOB) 14-4, except for Dike Alignment No 5. The oyster bar encompasses nearly 3,400 acres. A significant portion of the oyster bar is located to the west of the original 1847 island footprint. Deep water for a potential access channel is located approximately one mile to the west and one-half miles to the southeast.

In the Sharps Island vicinity, water depths are shallower along the east and south shorelines of the proposed island footprint, with water depths ranging from -8.0 to -10.0 ft Mean Lower Low Water (MLLW). Depths along the west and north sides are deeper, ranging between -11.0 and -14.0 ft MLLW.

Three potential dike alignment options were initially reviewed. Upon further investigation, one of the alignments was ruled out due to limited capacity. The alignment that was ruled out encompassed approximately 415 acres and would not meet the required capacity of 40 Million Cubic Yards (MCY) (even if the dikes were constructed to +20 ft with no wetlands).

AMA and BBL decided on the three other dike options that would be reviewed. The three alignments range in size from 1,070 acres to 2,260 acres, and would meet the capacity requirement of 40 MCY to 80 MCY. Figures 4 to 13 detail the alignment options.

Dike alignment options were based on geotechnical information gathered in the field (E2CR, 2002), the original 1847 foot print for Sharps Island and the proximity to NOB 14-4. Consideration was also given to the surrounding water depths. Constructing a rock revetment in deep water will increase the cost of the project significantly due to the quantity of stone that would be required in deeper waters. Therefore, keeping the foot print of the proposed island within the 12 ft contour tends to be the most economical.

3.2 Design Characteristics

Digital hydrographic data were obtained from the National Ocean Service GEOphysical Data System (GEODAS) data set. This digital data includes all of the National Oceanic Atmospheric Administration (NOAA) bathymetry utilized to generate the local navigation charts and provides detailed information for the study area. Analysis of this data indicates that water depths are shallower along the east and south shorelines of the proposed dredged material island, with depths ranging from - 8.0 to –10.0 ft MLLW. Depths along the west and north sides are deeper, ranging between –11.0 and –14.0 ft MLLW. Refer to Figure 2 for the bathymetry plan. The dike alignments and geotechnical boring plan used by E2CR (2002) were overlaid with the proposed alignments. The boring overlay can be found in Figure 3.

Note that additional geotechnical data will be required for the feasibility, planning and design phases of this project.

<u>Dike Alignment No. 1</u> – Encompasses 1,840 acres and will be divided equally into uplands and wetlands (figures 4 and 5). The wetlands will be located to the eastern portion of the proposed island. When wetland

construction is completed, the dikes may be breached to allow tidal flow in and out of the wetland cells. The east side of the dike is more protected so that waves approaching the breaches will be minimal compared to other directions. Approximately 1,455 acres of the proposed alignment is located within the oyster bar. The proposed dike alignment overlaps the original 1847 footprint by 277 acres. None of the 1942 footprint is located within the interior of the proposed alignment.

Dike Alignment No. 2 – Encompasses 2,260 acres and is divided equally into uplands and wetlands, (figures 6 and 7). The wetlands will be located on the eastern portion of the proposed island. The 420 additional acres were added on the northeast corner of Dike Alignment No. 1 to arrive at Dike Alignment No. 2. Approximately 1,460 acres of the proposed alignment is located within the oyster bar. Dike Alignment No. 2 would be breached similarly to Dike Alignment No.1. The proposed dike alignment overlaps the original 1847 footprint by 354 acres. None of the 1942 footprint is located within the interior of the proposed alignment.

Dike Alignment No. 3 – Encompasses 1,200 acres and is divided equally into uplands and wetlands, (figures 8 and 9). In this alignment, the uplands are located to the north and the wetlands are located to the south unlike the other alignments, the island is split in two by an east-west cross-dike. This configuration differs from the other two alignments because of the shape of the island and the concern of developing very long and narrow cells. Long and narrow cells may restrict inflow operations and flow of material to the outer extents away from the inflow locations. Another difference between Dike Alignment 3 and the previous two options is that the overall footprint located within the oyster bar has been reduced. The breaching of the dikes, to allow tidal interaction with the wetland cells, would occur along the south west portion of the dike. Approximately 565 acres of the proposed alignment is located within the oyster bar. The proposed dike alignment overlaps the original 1847 footprint by 354 acres. None of the 1942 footprint is located within the interior of the proposed alignment.

Dike Alignment No. 4 – Encompasses 1,520 acres and is divided equally into uplands and wetlands (figures 10 and 11). The wetlands will be located on the eastern portion of the proposed island and breached in a manner similar to Alignments 1 and 2. Approximately 600 acres of the proposed alignment is located within the oyster bar. The proposed dike alignment overlaps the original 1847 footprint by 439 acres. The entire 1942 footprint is located within the interior of the proposed alignment.

Dike Alignment No. 5 – Encompasses 1,070 acres and is divided equally into uplands and wetlands similar to Alignment Option 1 and 2 (figures 12 and 13). The main difference is that the uplands are located to the north and the wetlands are located to the south. Another significant difference is that the entire site is located outside the oyster bar. The oyster bar and the proposed alignment share two common sides (i.e., the eastern and southeastern edges of the oyster bar). The proposed dike alignment overlaps the original 1847 footprint by 152 acres. The entire 1942 footprint is located within the interior of the proposed alignment.

The primary exposure of Sharps Island shoreline to heavy wave action is from the north, south and the west as stated in the Coastal Engineering Reconnaissance Report (AMA, 2002). The eastern portion of the proposed alignments will be exposed to limited wave action due to the fetch distance to the shoreline to the east of the island.

The proposed dike sections are broken into two designations, A and B. Typical dike sections 1A-6A are for a facility that will be constructed to an elevation of +10 ft MLLW for the upland portion and to +10 or +7 ft MLLW for the wetland portion. Typical dike sections 1B-5B are for a facility that will be constructed to an elevation of +20 ft MLLW for the upland portion and to +10 or +7 ft MLLW for the wetland portion. The perimeter dike sections are 1A-4A, 6A, 1B-3B, and 5B. The interior crossdikes/longitudinal dikes are 5A and 4B. Again, the designation of "A" and "B" is the difference in dike design between +10 ft and +20 ft respectively. Only the upland portion would potential be raised to +20 ft MLLW. Wetland dikes are typically lower than +10 ft, because the marsh elevations are typically lower than 2.5 ft. The perimeter dike elevation (for the wetland cells) is primarily a function of wave height and wave run-up and is not controlled by site capacity. The typical dike sections are shown in Figures 14 to 19.

Each perimeter dike section is composed of a sand core covered with a stone revetment on the side facing the water. The armor stone is composed of different weight stones for dike sections that may be prone to higher wave forces. The armor stone has a geotextile fabric laid underneath of it to help support the weight of the stone and to reduce erosion of the sand core. Each perimeter dike section will have roadway on top of it to allow vehicles to travel the perimeter. The road width will be 20 ft wide. The rock revetment will have a slope of 3 ft horizontal to 1 ft vertical. The interior dike slope will have a slope of 5 ft horizontal to 1 ft vertical. The 20 ft dike will have an interior slope of 3 horizontal to 1 ft vertical with a crest width 12 ft. The interior dike sections have a crest width of 20 ft and slope of 3 horizontal to 1 ft vertical. Tables 1 to 5 outlines that material quantities associated with the construction of each dike section.

4. Alternate Borrow Methods

The estimated neat dike fill quantities for construction of the perimeter dikes with the various alternatives are summarized as:

Alignment No.	Material required for dike construction (10 ft, mcy)	Material required for dike construction (20 ft, mcy)
1	3.8	5.9
2	4.4	6.7
3	2.6	3.7
4	2.8	4.3
5	2.5	3.2

Note that this estimate does not include quantities for the interior dikes (which divide the island into sub-cells). However, the estimate does reflect one longitudinal dike to split the proposed island into upland and wetland areas. Based on a review of the Geotechnical Report (E2CR, 2002), it appears that there will be ample sand on-site for dike construction.

Two sand sources were reviewed. Alternative 1 involves mining sand from an on-site borrow source using a hydraulic dredge. Alternative 2 involves using a clamshell dredge to mine the sand from an off-site source, and then transport the material to the site via a scow.

Under Alternative 1, the mined sand will be stockpiled and hauled by truck, and placed mechanically (or pumped hydraulically) into the dike template. Under Alternative 2, the mined sand (possibly in the Craighill Channel) will be transported to the site and dumped and placed in deep water. The material would be stockpiled underwater and then moved a second time by a hydraulic dredge and pumped into template.

The quantity of material located within the footprint for each alignment option and the quantity of material located outside the footprint are summarized below:

Alignment No.	Material inside the footprint (mcy)	Material outside the footprint (mcy)
1	11.0	10.0
2	19.0	2.0
3	5.5	15.5
4	5.0	16.0
5	6.6	14.4

5. Cost Analysis

The costs associated with the construction of Sharps Island are based on the proposed dike alignments, typical dike sections, and the equipment that will be required for construction of the island. The unit costs used for the estimate are based on similar reconnaissance level projects in the Chesapeake Bay, and actual construction costs associated with the Poplar Island project (GBA, 2001, 2002). A detailed summary of the construction cost associated with the proposed alignments can be found in Tables 6 and 7.

The preliminary construction costs are separated by material type/size, and the different sand borrow alternatives. The materials that would be required are:

- Sand – the material required to create the "core" of the dike;
- Geotextile fabric – a synthetic material used between the sand core dike and the armor stone, and roadway stone;
- Armor stone – different size stones used to protect the dike structure from wave attack; and
- Road stone - material to cover the tops of all roadway dikes for driving purposes.

Other items that are part of the island construction are spillways for water discharge, a personnel pier and a nursery planting area. The fees associated with the engineering design and other related studies associated with the island are also included.

A summary of the estimated dike construction costs, using borrow Alternative 1, for the 10 ft alignments are given below.

Dike Alignment No.	Dike construction cost (10 ft)
1	$100 M
2	$116 M
3	$80 M
4	$61 M
5	$81 M

A summary of the estimated dike construction costs, using borrow Alternative 1, for the 20 ft dike are given below.

Dike Alignment No.	Dike construction cost (20 ft)
1	$118 M
2	$136 M
3	$90 M
4	$74 M
5	$88 M

The total site use cost analysis for each dike alignment and dike option is composed of the following elements:

- Study cost (reconnaissance, pre-feasibility and feasibility);
- Total construction cost;

- Site development cost (dredged material management, site maintenance and site monitoring and reporting);
- Habitat development cost (plans and design, monitoring, implementation, and operation and maintenance); and
- Dredging, transport and placement cost (mobilization & demobilization, dredging, transport, and placement).

Tables 8 to 17 detail the associated costs.

A summary of the estimated total site use costs for a 10 ft dike are given below:

Alignment No.	Total site use cost	Total unit cost
1	$743 M	$16.37
2	$911 M	$16.56
3	$484 M	$16.48
4	$530 M	$15.80
5	$432 M	$17.29

A summary of the estimated total site use costs for a 20 ft dike are given below:

Alignment No.	Total site use cost	Total unit cost
1	$1,016 M	$15.59
2	$1,251 M	$15.77
3	$652 M	$15.41
4	$748 M	$14.98
5	$579 M	$15.85

6. Summary and Conclusions

Based on our review of available data related to this project, the construction of Sharps Island is technically feasible. The initial cost to construct the island ranges from $ 61 M to $136 M, and the projected schedule for construction of the island would be 3 to 5 years (depending on the number of contracts required to complete the construction). Total site use cost ranged from $432 M to $1,250 M (for Alignments no. 5 and no. 2 respectively). Total unit cost ranged from $14.98/cy to $17.29/cy (for Alignments no. 4 and no. 5 respectively). Alignment 4 with the upland portion constructed to +20 ft provides the best unit cost ($14.98/cy) for the allotted storage capacity of approximately 50 mcy.

All of the alignments encroached into the natural oyster bar No. 14-4, except Alignment no. 5. Alignment no. 5 with the upland portion constructed to +20 ft provides the best unit cost for the allotted storage capacity of 37 MCY for a site not located within the oyster bar foot print. The total site use cost for Alignment no. 5 (constructed to +20-ft) would be $579 M and the total unit cost would be $15.85/cy.

Note that the analysis in this study was conducted at a reconnaissance level, and therefore, the results should be considered only for preliminary planning purposes. A feasibility study and an engineering design are recommended before implementation of the proposed project.

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Tables

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Table 1. Site Characteristics and Quantities for Dike Alignment No. 1

SITE CHARACTERISTICS	Upland Dike Construction to +10			Upland Dike Construction to +20		
Upland						
Upland Baseline Area -	920	Ac.		920	Ac.	
Upland Baseline Perimeter -	21,013	LF		21,013	LF	
Upland Site Volume Below Sea Level -	13.7	MCY		13.7	MCY	
Upland Site Volume Above Sea Level -	11.9	MCY		26.7	MCY	
Upland Volume -	25.5	MCY		40.4	MCY	
Upland Site Capacity -	29.5	MCY		49.3	MCY	
Wetland						
Wetland Baseline Area -	920	Ac.		920	Ac.	
Wetland Baseline Perimeter -	20,187	LF		20,187	LF	
Wetland Site Volume Below Sea Level -	13.7	MCY		13.7	MCY	
Wetland Site Volume Above Sea Level -	2.2	MCY		2.2	MCY	
Wetland Volume -	15.9	MCY		15.9	MCY	
Wetland Site Capacity -	15.9	MCY		15.9	MCY	
Upland and Wetland Totals						
Total Baseline Area -	1,840	Ac.		1,840	Ac.	
Total Baseline Perimeter -	41,200	LF		41,200	LF	
Total Volume -	41	MCY		56	MCY	
Total Site Capacity -	45	MCY		65	MCY	
Volume of Available Sand Within Diked Area -	11	MCY		11	MCY	
QUANTITIES	Upland Dike Construction to +10			Upland Dike Construction to +20		
Dike Fill Material	LF	CY/LF	CY	LF	CY/LF	CY
Unsuitable Backfill Replaced w/Clean Sand -			450,000			450,000
Typical Perimeter Dike Section 1A to +10 -	20,755	78	1,618,890	2,128	78	165,984
Typical Perimeter Dike Section 1B to +20 -				18,627	137	2,551,899
Typical Perimeter Dike Section 2A to +10 -						
Typical Perimeter Dike Section 2B to +20 -						
Typical Perimeter Dike Section 3A to +12 -	8,698	66	574,068	6,313	66	416,658
Typical Perimeter Dike Section 3B to +20 -				2,385	108	257,580
Typical Perimeter Dike Section 4A to +7 -	11,745	37	434,565	11,745	37	434,565
Typical Interior Dike Section 5A to +10 -	15,714	49	769,986			
Typical Interior Dike Section 4B to +20 -				15,714	107	1,681,398
Total -	56,912		3,847,509	56,912		5,958,084
	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Typical Perimeter Dike Section 1A and 1B-						
Quarry Run -	20,755	1.4	29,979	20,755	1.4	29,979
Toe Armor -	20,755	5.2	107,619	20,755	5.2	107,619
Underlayer Stone -	20,755	9.8	202,938	20,755	9.8	202,938
Slope Dike Armor -	20,755	21.0	435,086	20,755	21.0	435,086
Typical Perimeter Dike Section 3A and 3B-						
Quarry Run -	8,698	0.9	8,215	8,698	0.9	8,215
Toe Armor -	8,698	5.7	49,611	8,698	5.7	49,611
Underlayer Stone -	8,698	8.7	76,027	8,698	8.7	76,027
Slope Dike Armor -	8,698	18.3	159,141	8,698	18.3	159,141
Typical Perimeter Dike Section 4A-						
Quarry Run -	11,745	0.9	11,093	11,745	0.9	11,093
Toe Armor -	11,745	5.7	66,990	11,745	5.7	66,990
Underlayer Stone -	11,745	6.0	70,470	11,745	6.0	70,470
Slope Dike Armor -	11,745	12.3	144,420	11,745	12.3	144,420
Perimeter Dike Totals -	LF		Tons	LF		Tons
Total Quarry Run -	41,198		49,287	41,198		49,287
Total Toe Armor -	41,198		224,219	41,198		224,219
Total Underlayer Stone -	41,198		349,435	41,198		349,435
Total Slope Dike Armor -	41,198		738,647	41,198		738,647
MISCELLANEOUS MATERIALS						
	LF	SY/LF	SY	LF	SY/LF	SY
Road Stone -	56,912	2.2	125,206	56,912	2.2	125,206
Geotextile -	41,198	10.0	411,980	41,198	10.0	411,980

Notes: Volume accounts for 2 ft of freeboard
Assumed final average material elevation of 1.5 ft MLLW for wetland cells
Tons/lf conversions based on discussion with Arundel Corporation and Aggtrans
Bulking and shrinkage accounted for material above and below Elev. 0 MLLW

Table 2. Site Characteristics and Quantities for Dike Alignment No. 2

SITE CHARACTERISTICS	Upland Dike Construction to +10			Upland Dike Construction to +20		
Upland						
Upland Baseline Area -	1,130	Ac.		1,130	Ac.	
Upland Baseline Perimeter -	26,462	LF		26,462	LF	
Upland Site Volume Below Sea Level -	16.4	MCY		16.4	MCY	
Upland Site Volume Above Sea Level -	14.6	MCY		32.8	MCY	
Upland Volume -	31.0	MCY		49.2	MCY	
Upland Site Capacity -	35.9	MCY		60.2	MCY	
Wetland						
Wetland Baseline Area -	1,130	Ac.		1,130	Ac.	
Wetland Baseline Perimeter -	21,473	LF		21,473	LF	
Wetland Site Volume Below Sea Level -	16.4	MCY		16.4	MCY	
Wetland Site Volume Above Sea Level -	2.7	MCY		2.7	MCY	
Wetland Volume -	19.1	MCY		19.1	MCY	
Wetland Site Capacity -	19.1	MCY		19.1	MCY	
Upland and Wetland Totals						
Total Baseline Area -	2,260	Ac.		2,260	Ac.	
Total Baseline Perimeter -	47,935	LF		47,935	LF	
Total Volume -	50	MCY		68	MCY	
Total Site Capacity -	55	MCY		79	MCY	
Volume of Available Sand Within Diked Area -	19	MCY		19	MCY	
QUANTITIES	Upland Dike Construction to +10			Upland Dike Construction to +20		
Dike Fill Material	LF	CY/LF	CY	LF	CY/LF	CY
Unsuitable Backfill Replaced w/Clean Sand -			550,000			550,000
Typical Perimeter Dike Section 1A to +10 -	26,408	78	2,059,824	4,481	78	349,518
Typical Perimeter Dike Section 1B to +20 -				21,927	137	3,003,999
Typical Perimeter Dike Section 2A to +10 -						
Typical Perimeter Dike Section 2B to +20 -						
Typical Perimeter Dike Section 3A to +12 -	8,682	66	573,012	4,146	66	273,636
Typical Perimeter Dike Section 3B to +20 -				3,399	108	367,092
Typical Perimeter Dike Section 4A to +7 -	12,845	37	475,265	12,845	37	475,265
Typical Interior Dike Section 5A to +10 -	15,775	49	772,975			
Typical Interior Dike Section 4B to +20 -				15,775	108	1,703,700
Total -	63,710		4,431,076	62,573		6,723,210
	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Typical Perimeter Dike Section 1A and 1B-						
Quarry Run -	26,408	1.4	38,145	26,408	1.4	38,145
Toe Armor -	26,408	5.2	136,930	26,408	5.2	136,930
Underlayer Stone -	26,408	9.8	258,212	26,408	9.8	258,212
Slope Dike Armor -	26,408	21.0	553,590	26,408	21.0	553,590
Typical Perimeter Dike Section 3A and 3B-						
Quarry Run -	8,682	0.9	8,200	7,545	0.9	7,126
Toe Armor -	8,682	5.7	49,520	7,545	5.7	43,034
Underlayer Stone -	8,682	8.7	75,887	7,545	8.7	65,949
Slope Dike Armor -	8,682	18.3	158,848	7,545	18.3	138,046
Typical Perimeter Dike Section 4A-						
Quarry Run -	12,845	0.9	12,131	12,845	0.9	12,131
Toe Armor -	12,845	5.7	73,264	12,845	5.7	73,264
Underlayer Stone -	12,845	6.0	77,070	12,845	6.0	77,070
Slope Dike Armor -	12,845	12.3	157,946	12,845	12.3	157,946
Perimeter Dike Totals -	LF		Tons	LF		Tons
Total Quarry Run -	47,935		58,476	47,935		58,476
Total Toe Armor -	47,935		259,714	47,935		259,714
Total Underlayer Stone -	47,935		411,169	47,935		411,169
Total Slope Dike Armor -	47,935		870,384	47,935		870,384
MISCELLANEOUS MATERIALS						
	LF	SY/LF	SY	LF	SY/LF	SY
Road Stone -	63,710	2.2	140,162	63,710	2.2	140,162
Geotextile -	47,935	10.0	479,350	47,935	10.0	479,350

Notes: Volume accounts for 2 ft of freeboard
Assumed final average material elevation of 1.5 ft MLLW for wetland cells
Tons/lf conversions based on discussion with Arundel Corporation and Aggtrans
Bulking and shrinkage accounted for material above and below Elev. 0 MLLW

Table 3. Site Characteristics and Quantities for Dike Alignment No. 3

SITE CHARACTERISTICS						
Upland	Upland Dike Construction to +10			Upland Dike Construction to +20		
Upland Baseline Area -	600	Ac.		600	Ac.	
Upland Baseline Perimeter -	17,504	LF		17,504	LF	
Upland Site Volume Below Sea Level -	8.8	MCY		8.8	MCY	
Upland Site Volume Above Sea Level -	7.7	MCY		17.4	MCY	
Upland Volume -	16.6	MCY		26.2	MCY	
Upland Site Capacity -	19.1	MCY		32.0	MCY	
Wetland						
Wetland Baseline Area -	600	Ac.		600	Ac.	
Wetland Baseline Perimeter -	21,117	LF		21,117	LF	
Wetland Site Volume Below Sea Level -	8.8	MCY		8.8	MCY	
Wetland Site Volume Above Sea Level -	1.5	MCY		1.5	MCY	
Wetland Volume -	10.3	MCY		10.3	MCY	
Wetland Site Capacity -	10.3	MCY		10.3	MCY	
Upland and Wetland Totals						
Total Baseline Area -	1,200	Ac.		1,200	Ac.	
Total Baseline Perimeter -	38,621	LF		38,621	LF	
Total Volume -	27	MCY		36	MCY	
Total Site Capacity -	29	MCY		42	MCY	
Volume of Available Sand Within Diked Area -	6	MCY		6	MCY	
QUANTITIES	Upland Dike Construction to +10			Upland Dike Construction to +20		
Dike Fill Material	LF	CY/LF	CY	LF	CY/LF	CY
Unsuitable Backfill Replaced w/Clean Sand -			350,000			350,000
Typical Perimeter Dike Section 1A to +10 -	5,275	78	411,450			
Typical Perimeter Dike Section 1B to +20 -				5,277	137	722,949
Typical Perimeter Dike Section 2A to +10 -	12,731	53	674,743	7,252	53	384,356
Typical Perimeter Dike Section 2B to +20 -				5,478	107	586,146
Typical Perimeter Dike Section 3A to +12 -	8,084	66	533,544	8,084	66	533,544
Typical Perimeter Dike Section 3B to +20 -					108	-
Typical Perimeter Dike Section 4A to +7 -	12,531	37	463,647	5,778	37	213,786
Typical Interior Dike Section 5A to +10 -	2,350	80	188,000			
Typical Perimeter Dike Section 5B to +20 -				6,753	106	715,818
Typical Interior Dike Section 4B to +20 -				2,349	108	253,692
Total -	40,971		2,621,384	40,971		3,760,291
	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Typical Perimeter Dike Section 1A and 1B-						
Quarry Run -	5,275	1.4	7,619	5,277	1.4	7,619
Toe Armor -	5,275	5.2	27,352	5,277	5.2	27,352
Underlayer Stone -	5,275	9.8	51,578	5,277	9.8	51,578
Slope Dike Armor -	5,275	21.0	110,580	5,277	21.0	110,580
Typical Perimeter Dike Section 2A and 2B-						
Quarry Run -	12,731	0.9	12,024	12,730	0.9	12,024
Toe Armor -	12,731	5.7	72,614	12,730	5.7	72,614
Underlayer Stone -	12,731	7.6	96,190	12,730	7.6	96,190
Slope Dike Armor -	12,731	15.8	200,867	12,730	15.8	200,867
Typical Perimeter Dike Section 3A and 3B-						
Quarry Run -	8,084	0.9	7,635	8,084	0.9	7,635
Toe Armor -	8,084	5.7	46,109	8,084	5.7	46,109
Underlayer Stone -	8,084	8.7	70,660	8,084	8.7	70,660
Slope Dike Armor -	8,084	18.3	147,907	8,084	18.3	147,907
Typical Perimeter Dike Section 4A-						
Quarry Run -	12,531	0.9	11,835	5,778	0.9	11,835
Toe Armor -	12,531	5.7	71,473	5,778	5.7	71,473
Underlayer Stone -	12,531	6.0	75,186	5,778	6.0	75,186
Slope Dike Armor -	12,531	12.3	154,085	5,778	12.3	154,085
Perimeter Dike Totals -	LF		Tons	LF		Tons
Total Quarry Run -	38,621		39,113	38,621		39,113
Total Toe Armor -	38,621		217,548	38,621		217,548
Total Underlayer Stone -	38,621		293,614	38,621		293,614
Total Slope Dike Armor -	38,621		613,439	38,621		613,439
MISCELLANEOUS MATERIALS						
	LF	SY/LF	SY	LF	SY/LF	SY
Road Stone -	40,971	2.2	90,136	40,971	2.2	90,136
Geotextile -	38,621	10.0	386,210	38,621	10.0	386,210

Notes: Volume accounts for 2 ft of freeboard
Assumed final average material elevation of 1.5 ft MLLW for wetland cells
Tons/lf conversions based on discussion with Arundel Corporation and Aggtrans
Bulking and shrinkage accounted for material above and below Elev. 0 MLLW

Table 4. Site Characteristics and Quantities for Dike Alignment No 4

	Upland Dike Construction to +10			Upland Dike Construction to +20		
SITE CHARACTERISTICS						
Upland						
Upland Baseline Area -	760	Ac.		760	Ac.	
Upland Baseline Perimeter -	17,692	LF		17,692	LF	
Upland Site Volume Below Sea Level -	9.3	MCY		9.3	MCY	
Upland Site Volume Above Sea Level -	9.8	MCY		22.1	MCY	
Upland Volume -	19.1	MCY		31.4	MCY	
Upland Site Capacity -	22.4	MCY		38.7	MCY	
Wetland						
Wetland Baseline Area -	760	Ac.		760	Ac.	
Wetland Baseline Perimeter -	17,016	LF		17,016	LF	
Wetland Site Volume Below Sea Level -	9.3	MCY		9.3	MCY	
Wetland Site Volume Above Sea Level -	1.8	MCY		1.8	MCY	
Wetland Volume -	11.2	MCY		11.2	MCY	
Wetland Site Capacity -	11.2	MCY		11.2	MCY	
Upland and Wetland Totals						
Total Baseline Area -	1,520	Ac.		1,520	Ac.	
Total Baseline Perimeter -	34,708	LF		34,708	LF	
Total Volume -	30	MCY		43	MCY	
Total Site Capacity -	34	MCY		50	MCY	
Volume of Available Sand Within Diked Area -	5	MCY		5	MCY	
QUANTITIES	Upland Dike Construction to +10			Upland Dike Construction to +20		
Dike Fill Material	LF	CY/LF	CY	LF	CY/LF	CY
Unsuitable Backfill Replaced w/Clean Sand -			400,000			400,000
Typical Perimeter Dike Section 1A to +10 -	5,277	78	411,606	2,000		
Typical Perimeter Dike Section 1B to +20 -				3,274	137	448,538
Typical Perimeter Dike Section 2A to +10 -	12,731	53	674,743			
Typical Perimeter Dike Section 2B to +20 -				12,731	107	1,362,217
Typical Perimeter Dike Section 3A to +12 -	3,129	66	206,514	1,443		
Typical Perimeter Dike Section 3B to +20 -				1,686	108	182,088
Typical Perimeter Dike Section 4A to +7 -	13,572	37	502,164	13,572	37	502,164
Typical Interior Dike Section 5A to +10 -	13,122	49	642,978			
Typical Interior Dike Section 4B to +20 -				13,125	108	1,417,500
Total -	47,831		2,838,005	47,831		4,312,507
	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Typical Perimeter Dike Section 1A and 1B-						
Quarry Run -	5,277	1.4	7,622	5,274	1.4	7,622
Toe Armor -	5,277	5.2	27,362	5,274	5.2	27,362
Underlayer Stone -	5,277	9.8	51,597	5,274	9.8	51,597
Slope Dike Armor -	5,277	21.0	110,622	5,274	21.0	110,622
Typical Perimeter Dike Section 2A and 2B-						
Quarry Run -	12,731	0.9	12,024	12,731	0.9	12,024
Toe Armor -	12,731	5.7	72,614	12,731	5.7	72,614
Underlayer Stone -	12,731	7.6	96,190	12,731	7.6	96,190
Slope Dike Armor -	12,731	15.8	200,867	12,731	15.8	200,867
Typical Perimeter Dike Section 3A and 3B-						
Quarry Run -	3,129	0.9	2,955	3,129	0.9	2,955
Toe Armor -	3,129	5.7	17,847	3,129	5.7	17,847
Underlayer Stone -	3,129	8.7	27,350	3,129	8.7	27,350
Slope Dike Armor -	3,129	18.3	57,249	3,129	18.3	57,249
Typical Perimeter Dike Section 4A-						
Quarry Run -	13,572	0.9	12,818	13,572	0.9	12,818
Toe Armor -	13,572	5.7	77,411	13,572	5.7	77,411
Underlayer Stone -	13,572	6.0	81,432	13,572	6.0	81,432
Slope Dike Armor -	13,572	12.3	166,885	13,572	12.3	166,885
Perimeter Dike Totals -	LF		Tons	LF		Tons
Total Quarry Run -	34,709		23,396	34,709		23,396
Total Toe Armor -	34,709		122,620	34,709		122,620
Total Underlayer Stone -	34,709		160,379	34,709		160,379
Total Slope Dike Armor -	34,709		334,756	34,709		334,756
MISCELLANEOUS MATERIALS						
	LF	SY/LF	SY	LF	SY/LF	SY
Road Stone -	47,831	2.2	105,228	47,831	2.2	105,228
Geotextile -	34,709	10.0	347,090	34,709	10.0	347,090

Notes: Volume accounts for 2 ft of freeboard
Assumed final average material elevation of 1.5 ft MLLW for wetland cells
Tons/lf conversions based on discussion with Arundel Corporation and Aggtrans
Bulking and shrinkage accounted for material above and below Elev. 0 MLLW

Table 5. Site Characteristics and Quantities for Dike Alignment No. 5

SITE CHARACTERISTICS	Upland Dike Construction to +10		Upland Dike Construction to +20	
Upland				
Upland Baseline Area -	535	Ac.	535	Ac.
Upland Baseline Perimeter -	15,878	LF	15,878	LF
Upland Site Volume Below Sea Level -	7.3	MCY	7.3	MCY
Upland Site Volume Above Sea Level -	6.9	MCY	15.5	MCY
Upland Volume -	14.2	MCY	22.8	MCY
Upland Site Capacity -	16.5	MCY	28.0	MCY
Wetland				
Wetland Baseline Area -	535	Ac.	535	Ac.
Wetland Baseline Perimeter -	25,775	LF	25,775	LF
Wetland Site Volume Below Sea Level -	7.3	MCY	7.3	MCY
Wetland Site Volume Above Sea Level -	1.3	MCY	1.3	MCY
Wetland Volume -	8.5	MCY	8.5	MCY
Wetland Site Capacity -	8.5	MCY	8.5	MCY
Upland and Wetland Totals				
Total Baseline Area -	1,070	Ac.	1,070	Ac.
Total Baseline Perimeter -	41,653	LF	41,653	LF
Total Volume -	23	MCY	31	MCY
Total Site Capacity -	25	MCY	37	MCY
Volume of Available Sand Within Diked Area -	7	MCY	7	MCY

QUANTITIES	Upland Dike Construction to +10			Upland Dike Construction to +20		
Dike Fill Material	LF	CY/LF	CY	LF	CY/LF	CY
Unsuitable Backfill Replaced w/Clean Sand -			300,000			300,000
Typical Perimeter Dike Section 1A to +10 -	5,124	78	399,672			
Typical Perimeter Dike Section 1B to +20 -				5,124	137	701,988
Typical Perimeter Dike Section 2A to +10 -	18,297	53	969,741	11,865	53	628,845
Typical Perimeter Dike Section 2B to +20 -				6,432	107	688,224
Typical Perimeter Dike Section 3A to +12 -	1,648	66	108,768	1,648	66	108,768
Typical Perimeter Dike Section 3B to +20 -						
Typical Perimeter Dike Section 4A to +7 -	12,262	37	453,694	12,262	37	453,694
Typical Interior Dike Section 5A to +10 -	3,475	80	278,000			
Typical Interior Dike Section 4B to +20 -				3,475	108	375,300
Typical Perimeter Dike Section 6A to +10 -	4,320	53	228,960			
Typical Perimeter Dike Section 5B to +20 -				4,320	106	457,920
Total -	45,126		2,509,875	45,126		3,256,819
	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Typical Perimeter Dike Section 1A and 1B-						
Quarry Run -	5,124	1.4	7,401	5,124	1.4	7,401
Toe Armor -	5,124	5.2	26,569	5,124	5.2	26,569
Underlayer Stone -	5,124	9.8	50,101	5,124	9.8	50,101
Slope Dike Armor -	5,124	21.0	107,414	5,124	21.0	107,414
Typical Perimeter Dike Section 2A and 2B-						
Quarry Run -	18,297	0.9	17,281	18,297	0.9	17,281
Toe Armor -	18,297	5.7	104,381	18,297	5.7	104,361
Underlayer Stone -	18,297	7.6	138,244	18,297	7.6	138,244
Slope Dike Armor -	18,297	15.8	288,686	18,297	15.8	288,686
Typical Perimeter Dike Section 3A and 3B-						
Quarry Run -	1,848	0.9	1,556	1,848	0.9	1,556
Toe Armor -	1,648	5.7	9,400	1,648	5.7	9,400
Underlayer Stone -	1,648	8.7	14,405	1,648	8.7	14,405
Slope Dike Armor -	1,648	18.3	30,152	1,648	18.3	30,152
Typical Perimeter Dike Section 4A-						
Quarry Run -	12,262	0.9	11,581	12,262	0.9	11,581
Toe Armor -	12,262	5.7	69,939	12,262	5.7	69,939
Underlayer Stone -	12,262	6.0	73,572	12,262	6.0	73,572
Slope Dike Armor -	12,262	12.3	150,777	12,262	12.3	150,777
Typical Perimeter Dike Section 6A and 5B-						
Quarry Run -	4,320	0.9	4,080	4,320	0.9	4,080
Toe Armor -	4,320	5.7	24,640	4,320	5.7	24,640
Underlayer Stone -	4,320	7.8	33,600	4,320	7.8	33,600
Slope Dike Armor -	4,320	15.7	67,840	4,320	15.7	67,840
Perimeter Dike Totals -	LF		Tons	LF		Tons
Total Quarry Run -	41,651		41,899	41,651		41,899
Total Toe Armor -	41,651		234,908	41,651		234,908
Total Underlayer Stone -	41,651		309,922	41,651		309,922
Total Slope Dike Armor -	41,651		644,870	41,651		644,870
MISCELLANEOUS MATERIALS						
	LF	SY/LF	SY	LF	SY/LF	SY
Road Stone -	45,126	2.2	99,277	45,126	2.2	99,277
Geotextile -	41,651	10.0	416,510	41,651	10.0	416,510

Notes: Volume accounts for 2 ft of freeboard
Assumed final average material elevation of 1.5 ft MLLW for wetland cells
Tons/lf conversions based on discussion with Arundel Corporation and Aggtrans
Bulking and shrinkage accounted for material above and below Elev. 0 MLLW

Table 6. Summary of Construction Cost - (for 10-ft Dikes)

			Dike Alignment No. 1		Dike Alignment No. 2		Dike Alignment No. 3		Dike Alignment No. 4		Dike Alignment No. 5	
Item	**Unit**	**Unit Rate**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**
Mobilization/Demobilization	L.S.	N/A	1	$ 3,250,000		$ 3,300,000	1	$3,000,000	1	$ 3,000,000	1	$ 3,150,000
Road Stone	S.Y.	$ 11.00	125,206	$ 1,377,000	140,162	$ 1,542,000	90,136	$ 991,000	105,228	$ 1,158,000	99,277	$ 1,092,000
Geotextile	S.Y.	$ 3.50	411,980	$ 1,442,000	479,350	$ 1,678,000	386,210	$ 1,352,000	347,090	$ 1,215,000	416,510	$ 1,458,000
Personnel Pier	L.S.	$ 500,000	1	$ 500,000	1	$ 500,000	1	$ 500,000	1	$ 500,000	1	$ 500,000
Unsuitable Foundation Excavation	C.Y.	$ 8.75	450,000	$ 3,938,000	550,000	$ 4,813,000	350,000	$ 3,063,000	400,000	$ 3,500,000	300,000	$ 2,625,000
Stone Work												
Quarry Run	Ton	$ 33.00	49,287	$ 1,626,000	58,476	$ 1,930,000	39,113	$ 1,291,000	23,396	$ 772,000	41,899	$ 1,383,000
Toe Armor	Ton	$ 44.00	224,219	$ 9,866,000	259,714	$ 11,427,000	217,548	$ 9,572,000	122,620	$ 5,395,000	234,908	$ 10,336,000
Underlayer	Ton	$ 39.00	349,435	$ 13,628,000	411,169	$ 16,036,000	293,614	$ 11,451,000	160,379	$ 6,255,000	309,922	$ 12,087,000
Slope Dike Armor Stone	Ton	$ 39.00	738,647	$ 28,807,000	870,384	$ 33,945,000	613,439	$ 23,924,000	334,756	$13,055,000	644,870	$ 25,150,000
Spillways	Each	$ 200,000	6	$ 1,200,000	6	$ 1,200,000	6	$ 1,200,000	6	$ 1,200,000	6	$ 1,200,000
Nursery Planting	L.S.	$ 200,000	1	$ 200,000	1	$ 200,000	1	$ 200,000	1	$ 200,000	1	$ 200,000
SUBTOTAL				$ 65,834,000		$ 76,571,000		$ 56,544,000		$ 36,250,000		$ 59,181,000
			Qty	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**	**Qty**	**Cost**
Borrow Alternative 1												
Hydraulic Stockpile - Mechanical Placement	C.Y.	$ 8.80	3,847,509	$ 33,858,000	4,431,076	$ 38,993,000	2,621,384	$ 23,068,000	2,838,005	$ 24,974,000	2,509,875	$ 22,087,000
Alt. 1 TOTAL CONSTRUCTION COST				***$ 99,692,000***		***$ 115,564,000***		***$ 79,612,000***		***$ 61,224,000***		***$ 81,268,000***
per cy of Site Capacity				$ 2.20		$ 2.10		$ 2.71		$ 1.82		$ 3.25
Borrow Alternative 2												
Clamshell Dredge from the Craighill Channe	C.Y.	$ 2.00	3,847,509	$ 7,695,000	4,431,076	$ 8,862,000	2,621,384	$ 5,243,000	2,838,005	$ 5,676,000	2,509,875	$ 5,020,000
31 nautical miles one way barge transport	C.Y.	$ 3.10	3,847,509	$ 11,927,000	4,431,076	$ 13,736,000	2,621,384	$ 8,126,000	2,838,005	$ 8,798,000	2,509,875	$ 7,781,000
Dike fill hydraulically from a barge with unloa	C.Y.	$ 7.50	3,847,509	$ 28,856,000	4,431,076	$ 33,233,000	2,621,384	$ 19,660,000	2,838,005	$ 21,285,000	2,509,875	$ 18,824,000
Alt. 2 TOTAL CONSTRUCTION COST				***$ 114,312,000***		***$ 132,402,000***		***$ 89,573,000***		***$ 72,009,000***		***$ 90,806,000***
per CY of Site Capacity				$ 2.52		$ 2.41		$ 3.05		$ 2.15		$ 3.63

NOTES:

Unit Rate cost from RSMeans (2002), GBA (2001) and GBA (2002).
Hydraulic stockpile and mechanical placement would involve end-dump trucking operation similar to Poplar Phase I and Phase II construction
Assumed hydraulic unloader would be similar to one used by Great Lakes or Norfolk
Stone source and placement technique assumed to be similar to one used during Poplar Phase I and Phase II construction
Site Capacity accounts for bulking and shrinkage of material

Table 7. Summary of Construction Cost - (for 20-ft Dikes)

			Dike Alignment No. 1		Dike Alignment No. 2		Dike Alignment No. 3		Dike Alignment No. 4		Dike Alignment No. 5	
Item	Unit	Unit Rate	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost
Mobilization/Demobilization	L.S.	N/A	1	$ 3,250,000	1	$ 3,300,000	1	$ 3,000,000	1	$ 3,000,000	1	$ 3,150,000
Road Stone	S.Y.	$ 11.00	125,206	$ 1,377,000	140,162	$ 1,542,000	90,136	$ 991,000	105,228	$ 1,158,000	99,277	$ 1,092,000
Geotextile	S.Y.	$ 3.50	411,980	$ 1,442,000	479,350	$ 1,676,000	386,210	$ 1,352,000	347,090	$ 1,215,000	416,510	$ 1,458,000
Personnel Pier	L.S.	$ 500,000	1	$ 500,000	1	$ 500,000	1	$ 500,000	1	$ 500,000	1	$ 500,000
Unsuitable Foundation Excavation	C.Y.	$ 6.75	450,000	$ 3,936,000	550,000	$ 4,613,000	350,000	$ 3,063,000	400,000	$ 3,500,000	300,000	$ 2,625,000
Stone Work												
Quarry Run	Ton	$ 33.00	49,287	$ 1,626,000	58,478	$ 1,930,000	39,113	$ 1,291,000	23,398	$ 772,000	41,899	$ 1,363,000
Toe Armor	Ton	$ 44.00	224,219	$ 9,666,000	259,714	$ 11,427,000	217,548	$ 9,572,000	122,620	$ 5,395,000	234,908	$ 10,336,000
Underlayer	Ton	$ 39.00	349,435	$ 13,628,000	411,189	$ 18,038,000	293,614	$ 11,451,000	160,379	$ 6,255,000	309,922	$ 12,087,000
Slope Dike Armor Stone	Ton	$ 39.00	736,647	$ 28,807,000	870,384	$ 33,945,000	613,439	$ 23,924,000	334,756	$ 13,055,000	644,670	$ 25,150,000
Spillways	Each	$ 200,000	6	$ 1,200,000	6	$ 1,200,000	6	$ 1,200,000	6	$ 1,200,000	6	$ 1,200,000
Nursery Planting	L.S.	$ 200,000	1	$ 200,000	1	$ 200,000	1	$ 200,000	1	$ 200,000	1	$ 200,000
SUBTOTAL				$ 65,634,000		$ 76,571,000		$ 58,544,000		$ 36,250,000		$ 59,181,000

			Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost	Qty	Cost
Borrow Alternative 1												
Hydraulic Stockpile - Mechanical Placement	C.Y.	$ 6.60	5,958,084	$ 52,431,000	8,723,210	$ 59,184,000	3,760,291	$ 33,091,000	4,312,507	$ 37,950,000	3,258,819	$ 26,660,000
Alt. 1 TOTAL CONSTRUCTION COST				***$ 118,265,000***		***$ 135,735,000***		***$ 89,635,000***		***$ 74,200,000***		***$ 87,841,000***
per cy of Site Capacity				$ 2.61		$ 2.47		$ 3.05		$ 2.21		$ 3.51
Borrow Alternative 2												
Clamshell Dredge from the Craighill Channel	C.Y.	$ 2.00	5,956,084	$ 11,916,000	6,723,210	$ 13,446,000	3,760,291	$ 7,521,000	4,312,507	$ 6,625,000	3,256,819	$ 6,514,000
31 nautical miles one way barge transport	C.Y.	$ 3.10	5,956,084	$ 18,470,000	6,723,210	$ 20,842,000	3,760,291	$ 11,657,000	4,312,507	$ 13,369,000	3,256,819	$ 10,096,000
Dike fill hydraulically from a barge with unload	C.Y.	$ 7.50	5,956,084	$ 44,886,000	6,723,210	$ 50,424,000	3,760,291	$ 26,202,000	4,312,507	$ 32,344,000	3,256,619	$ 24,426,000
Alt. 2 TOTAL CONSTRUCTION COST				***$ 140,906,000***		***$ 161,283,000***		***$ 103,924,000***		***$ 90,588,000***		***$ 100,217,000***
per CY of Site Capacity				$ 3.11		$ 2.93		$ 3.54		$ 2.70		$ 4.01

NOTES:

Unit Rate cost from RSMeans (2002), GBA (2001) and GBA (2002).
Hydraulic stockpile and mechanical placement would involve end-dump trucking operation similar to Poplar Phase I and Phase II construction
Assumed hydraulic unloader would be similar to one used by Great Lakes or Norfolk
Stone source and placement technique assumed to be similar to one used during Poplar Phase I and Phase II construction
Site Capacity accounts for bulking and shrinkage of material

Table 8. Total Site Use Cost Analysis for Dike Alignment No. 1 (10 ft)

Basis For Estimate:

Site Capacity (mcy)	45	Site Surface Area (ac)	1,840
Site Operating Life (Years)	18	Site Perimeter Dike (ft)	41,200
Annual Channel Volume (Million Cut Yards)	2.5	Site Interior Dikes (ft)	15,714
Average One Way Haul Distance (nm)	36	Final Dike Elevation (ft)	10.0

Item	Quantity	Unit	Unit Cost	Item Cost
A. Initial Construction Costs				***$ 102,692,000***
Total Construction Costs				$ 99,692,000
Study Costs				$ 3,000,000
B. Site Development Costs				***$ 102,968,000***
Dredged Material Management	18	Year	$ 1,944,000	$ 35,279,000
Site Maintenance	20	Year	$ 2,651,130	$ 53,414,000
Site Monitoring and Reporting	21	Year	$ 675,000	$ 14,275,000
Subtotal Annual Cost			***5,270,000***	
C. Site Finishing Cost (Habitat Development)				***$ 47,891,000***
Planning and Design	3	Year	$ 1,000,000	$ 3,000,000
Monitoring	18	Year	$ 250,000	$ 4,537,000
Implementation				
Channels	920	Acre	$ 4,000	$ 3,680,000
Planting/Seeding	1,840	Acre	$ 15,000	$ 27,600,000
Operation and Maintenance	18	Year	$ 500,000	$ 9,074,000
D. Dredging, Transportation & Placement Costs				***$ 392,442,000***
Mob and Demob	18	Year	$ 2,000,000	$ 36,295,000
Dredging	45.4	Mcy	$ 2.00	$ 90,738,000
Transport	45.4	Mcy	$ 3.60	$ 163,329,000
Placement	45.4	Mcy	$ 2.25	$ 102,080,000
Subtotal Cost A+B+C+D				***$ 645,993,000***
Contingency	15.00%			$ 96,899,000
Total Cost A+B+C+D				***$ 742,892,000***
Total Unit Cost				**$ 16.37**

NOTES:

Total construction cost are based on estimates from Table 6, Borrow Alternative 1
Study cost accounts for conceptual, pre-feasibility and feasibility cost
Dredged material management and costs associated with the lifespan of inflow
Site Maintenance costs are calculated by $150,000+$975/ac and then for an additional 2 years following final inflow
Site monitoring and reporting cost based on costs associated with Poplar Island. Includes Environmental monitoring for operations and 3 years following final placement
Channel construction cost based on excavation of channels within the wetland cells.
It is assumed that the channel dredging will be approximately 2 cy/lf. It is assumed that there will be 250 lf of channel per acre
Planting and seeding esimates based on recent 4D and Notch area plantings for Poplar Island
Mobilization and Demobilization is for the inflow lifespan of the project
Dredging is assumed to be clamshell dredging
Assumed transportation of the material will be $0.10/cy per nautical mile
Placement of the material into the island will be performed by a hydraulic unloader
15 % Contingency assumed to account for unknown factors at this level of study
Unit Rate cost from RSMeans (2002), GBA (2001) and GBA (2002).

Table 9. Total Site Use Cost Analysis for Dike Alignment No. 1 (20 ft)

Basis For Estimate:

Site Capacity (mcy)	65	Site Surface Area (ac)	1,840
Site Operating Life (Years)	26	Site Perimeter Dike (ft)	41,200
Annual Channel Volume (Cut Yards)	2.5	Site Interior Dikes (ft)	15,714
Average One Way Haul Distance (nm)	36	Final Dike Elevation (ft)	20.0

Item	Quantity	Unit	Unit Cost	Item Cost
A. Initial Construction Costs				***$ 121,265,000***
Total Construction Costs				$ 118,265,000
Study Costs				$ 3,000,000
B. Site Development Costs				***$ 144,687,000***
Dredged Material Management	26	Year	$ 1,944,000	$ 50,668,000
Site Maintenance	28	Year	$ 2,651,130	$ 74,401,000
Site Monitoring and Reporting	29	Year	$ 675,000	$ 19,618,000
Subtotal Annual Cost			***5,270,000***	
C. Site Finishing Cost (Habitat Development)				***$ 53,828,000***
Planning and Design	3	Year	$ 1,000,000	$ 3,000,000
Monitoring	26	Year	$ 250,000	$ 6,516,000
Implementation				
Channels	920	Acre	$ 4,000	$ 3,680,000
Planting/Seeding	1,840	Acre	$ 15,000	$ 27,600,000
Operation and Maintenance	26	Year	$ 500,000	$ 13,032,000
D. Dredging, Transportation & Placement Costs				***$ 563,628,000***
Mob and Demob	26	Year	$ 2,000,000	$ 52,127,000
Dredging	65.2	Mcy	$ 2.00	$ 130,319,000
Transport	65.2	Mcy	$ 3.60	$ 234,574,000
Placement	65.2	Mcy	$ 2.25	$ 146,608,000
Subtotal Cost A+B+C+D				***$ 883,408,000***
Contingency	15.00%			$ 132,511,000
Total Cost A+B+C+D				***$ 1,015,919,000***
Total Unit Cost				**$ 15.59**

NOTES:

Total construction cost are based on estimates from Table 6, Borrow Alternative 1
Study cost accounts for conceptual, pre-feasibility and feasibility cost
Dredged material management and costs associated with the lifespan of inflow
Site Maintenance costs are calculated by $150,000+$975/ac and then for an additional 2 years following final inflow
Site monitoring and reporting cost based on costs associated with Poplar Island. Includes Environmental monitoring for operations and 3 years following final placement
Channel construction cost based on excavation of channels within the wetland cells.
It is assumed that the channel dredging will be approximately 2 cy/lf. It is assumed that there will be 250 lf of channel per acre
Planting and seeding esimates based on recent 4D and Notch area plantings for Poplar Island
Mobilization and Demobilization is for the inflow lifespan of the project
Dredging is assumed to be clamshell dredging
Assumed transportation of the material will be $0.10/cy per nautical mile
Placement of the material into the island will be performed by a hydraulic unloader
15 % Contingency assumed to account for unknown factors at this level of study
Unit Rate cost from RSMeans (2002), GBA (2001) and GBA (2002).

Table 10. Total Site Use Cost Analysis for Dike Alignment No. 2 (10 ft)

Basis For Estimate:

Site Capacity (mcy)	55	Site Surface Area (ac)	2,260
Site Operating Life (Years)	22	Site Perimeter Dike (ft)	47,935
Annual Channel Volume (Cut Yards)	2.5	Site Interior Dikes (ft)	15,775
Average One Way Haul Distance (nm)	36	Final Dike Elevation (ft)	10

Item	Quantity	Unit	Unit Cost	Item Cost
A. Initial Construction Costs				***$ 118,564,000***
Total Construction Costs				$ 115,564,000
Study Costs				$ 3,000,000
B. Site Development Costs				***$ 139,609,000***
Dredged Material Management	22	Year	$ 2,353,500	$ 51,773,000
Site Maintenance	24	Year	$ 2,956,950	$ 70,962,000
Site Monitoring and Reporting	25	Year	$ 675,000	$ 16,874,000
Subtotal Annual Cost			***5,985,000***	
C. Site Finishing Cost (Habitat Development)				***$ 57,919,000***
Planning and Design	3	Year	$ 1,000,000	$ 3,000,000
Monitoring	22	Year	$ 250,000	$ 5,500,000
Implementation				
Channels	1,130	Acre	$ 4,000	$ 4,520,000
Planting/Seeding	2,260	Acre	$ 15,000	$ 33,900,000
Operation and Maintenance	22	Year	$ 500,000	$ 10,999,000
D. Dredging, Transportation & Placement Costs				***$ 475,714,690***
Mob and Demob	22	Year	$ 2,000,000	$ 43,997,000
Dredging	55.0	Mcy	$ 2.00	$ 109,992,000
Transport	55.0	Mcy	$ 3.60	$ 197,985,040
Placement	55.0	Mcy	$ 2.25	$ 123,740,650
Subtotal Cost A+B+C+D				***$ 791,806,690***
Contingency	15.00%			$ 118,771,000
Total Cost A+B+C+D				***$ 910,577,690***
Total Unit Cost				**$ 16.56**

NOTES:

Total construction cost are based on estimates from Table 6, Borrow Alternative 1

Study cost accounts for conceptual, pre-feasibility and feasibility cost

Dredged material management and costs associated with the lifespan of inflow

Site Maintenance costs are calculated by $150,000+$975/ac and then for an additional 2 years following final inflow

Site monitoring and reporting cost based on costs associated with Poplar Island. Includes Environmental monitoring for operations and 3 years following final placement

Channel construction cost based on excavation of channels within the wetland cells.

It is assumed that the channel dredging will be approximately 2 cy/lf. It is assumed that there will be 250 lf of channel per acre

Planting and seeding esimates based on recent 4D and Notch area plantings for Poplar Island

Mobilization and Demobilization is for the inflow lifespan of the project

Dredging is assumed to be clamshell dredging

Assumed transportation of the material will be $0.10/cy per nautical mile

Placement of the material into the island will be performed by a hydraulic unloader

15 % Contingency assumed to account for unknown factors at this level of study

Unit Rate cost from RSMeans (2002), GBA (2001) and GBA (2002).

Table 11. Total Site Use Cost Analysis for Dike Alignment No. 2 (20 ft)

Basis For Estimate:

Site Capacity (mcy)	79	Site Surface Area (ac)	2,260
Site Operating Life (Years)	32	Site Perimeter Dike (ft)	47,935
Annual Channel Volume (Cut Yards)	2.5	Site Interior Dikes (ft)	15,775
Average One Way Haul Distance (nm)	36	Final Dike Elevation (ft)	20.0

Item	Quantity	Unit	Unit Cost	Item Cost
A. Initial Construction Costs				***$ 138,735,000***
Total Construction Costs				$ 135,735,000
Study Costs				$ 3,000,000
B. Site Development Costs				***$ 197,805,000***
Dredged Material Management	32	Year	$ 2,353,500	$ 74,656,000
Site Maintenance	34	Year	$ 2,956,950	$ 99,712,000
Site Monitoring and Reporting	35	Year	$ 675,000	$ 23,437,000
Subtotal Annual Cost			***5,985,000***	
C. Site Finishing Cost (Habitat Development)				***$ 65,211,000***
Planning and Design	3	Year	$ 1,000,000	$ 3,000,000
Monitoring	32	Year	$ 250,000	$ 7,930,000
Implementation				
Channels	1,130	Acre	$ 4,000	$ 4,520,000
Planting/Seeding	2,260	Acre	$ 15,000	$ 33,900,000
Operation and Maintenance	32	Year	$ 500,000	$ 15,861,000
D. Dredging, Transportation & Placement Costs				***$ 685,975,000***
Mob and Demob	32	Year	$ 2,000,000	$ 63,443,000
Dredging	79.3	Mcy	$ 2.00	$ 158,607,000
Transport	79.3	Mcy	$ 3.60	$ 285,492,000
Placement	79.3	Mcy	$ 2.25	$ 178,433,000
Subtotal Cost A+B+C+D				***$ 1,087,726,000***
Contingency	15.00%			$ 163,159,000
Total Cost A+B+C+D				***$ 1,250,885,000***
Total Unit Cost				**$ 15.77**

NOTES:

Total construction cost are based on estimates from Table 6, Borrow Alternative 1
Study cost accounts for conceptual, pre-feasibility and feasibility cost
Dredged material management and costs associated with the lifespan of inflow
Site Maintenance costs are calculated by $150,000+$975/ac and then for an additional 2 years following final inflow
Site monitoring and reporting cost based on costs associated with Poplar Island. Includes Environmental monitoring for operations and 3 years following final placement
Channel construction cost based on excavation of channels within the wetland cells.
It is assumed that the channel dredging will be approximately 2 cy/lf. It is assumed that there will be 250 lf of channel per acre
Planting and seeding esimates based on recent 4D and Notch area plantings for Poplar Island
Mobilization and Demobilization is for the inflow lifespan of the project
Dredging is assumed to be clamshell dredging
Assumed transportation of the material will be $0.10/cy per nautical mile
Placement of the material into the island will be performed by a hydraulic unloader
15 % Contingency assumed to account for unknown factors at this level of study
Unit Rate cost from RSMeans (2002), GBA (2001) and GBA (2002).

Table 12. Total Site Use Cost Analysis for Dike Alignment No. 3 (10 ft)

Basis For Estimate:

Site Capacity (mcy)	29	Site Surface Area (ac)	1,200
Site Operating Life (Years)	12	Site Perimeter Dike (ft)	38,621
Annual Channel Volume (Cut Yards)	2.5	Site Interior Dikes (ft)	2,350
Average One Way Haul Distance (nm)	36	Final Dike Elevation (ft)	10.0

Item	Quantity	Unit	Unit Cost	Item Cost
A. Initial Construction Costs				***$ 82,612,000***
Total Construction Costs				$ 79,612,000
Study Costs				$ 3,000,000
B. Site Development Costs				***$ 52,087,000***
Dredged Material Management	12	Year	$ 1,320,000	$ 15,521,000
Site Maintenance	14	Year	$ 1,933,695	$ 26,604,000
Site Monitoring and Reporting	15	Year	$ 675,000	$ 9,962,000
Subtotal Annual Cost			***3,929,000***	
C. Site Finishing Cost (Habitat Development)				***$ 32,218,000***
Planning and Design	3	Year	$ 1,000,000	$ 3,000,000
Monitoring	12	Year	$ 250,000	$ 2,939,000
Implementation				
Channels	600	Acre	$ 4,000	$ 2,400,000
Planting/Seeding	1,200	Acre	$ 15,000	$ 18,000,000
Operation and Maintenance	12	Year	$ 500,000	$ 5,879,000
D. Dredging, Transportation & Placement Costs				***$ 254,267,000***
Mob and Demob	12	Year	$ 2,000,000	$ 23,516,000
Dredging	29.4	Mcy	$ 2.00	$ 58,790,000
Transport	29.4	Mcy	$ 3.60	$ 105,822,000
Placement	29.4	Mcy	$ 2.25	$ 66,139,000
Subtotal Cost A+B+C+D				***$ 421,184,000***
Contingency	15.00%			$ 63,178,000
Total Cost A+B+C+D				***$ 484,362,000***
Total Unit Cost				**$ 16.48**

NOTES:

Total construction cost are based on estimates from Table 6, Borrow Altemative 1

Study cost accounts for conceptual, pre-feasibility and feasibility cost

Dredged material management and costs associated with the lifespan of inflow

Site Maintenance costs are calculated by $150,000+$975/ac and then for an additional 2 years following final inflow

Site monitoring and reporting cost based on costs associated with Poplar Island. Includes Environmental monitoring for operations and 3 years following final placement

Channel construction cost based on excavation of channels within the wetland cells.
It is assumed that the channel dredging will be approximately 2 cy/lf. It is assumed that there will be 250 lf of channel per acre

Planting and seeding esimates based on recent 4D and Notch area plantings for Poplar Island

Mobilization and Demobilization is for the inflow lifespan of the project

Dredging is assumed to be clamshell dredging

Assumed transportation of the material will be $0.10/cy per nautical mile

Placement of the material into the island will be performed by a hydraulic unloader

15 % Contingency assumed to account for unknown factors at this level of study

Unit Rate cost from RSMeans (2002), GBA (2001) and GBA (2002).

Table 13. Total Site Use Cost Analysis for Dike Alignment No. 3 (20 ft)

Basis For Estimate:

Site Capacity (mcy)	42	Site Surface Area (ac)	1,200
Site Operating Life (Years)	17	Site Perimeter Dike (ft)	38,621
Annual Channel Volume (Cut Yards)	2.5	Site Interior Dikes (ft)	2,349
Average One Way Haul Distance (nm)	36	Final Dike Elevation (ft)	20

Item	Quantity	Unit	Unit Cost	Item Cost
A. Initial Construction Costs				***$ 92,635,000***
Total Construction Costs				$ 89,635,000
Study Costs				$ 3,000,000
B. Site Development Costs				***$ 72,367,000***
Dredged Material Management	17	Year	$ 1,320,000	$ 22,335,000
Site Maintenance	19	Year	$ 1,933,650	$ 36,586,000
Site Monitoring and Reporting	20	Year	$ 675,000	$ 13,446,000
Subtotal Annual Cost			***3,929,000***	
C. Site Finishing Cost (Habitat Development)				***$ 36,090,000***
Planning and Design	3	Year	$ 1,000,000	$ 3,000,000
Monitoring	17	Year	$ 250,000	$ 4,230,000
Implementation				
Channels	600	Acre	$ 4,000	$ 2,400,000
Planting/Seeding	1,200	Acre	$ 15,000	$ 18,000,000
Operation and Maintenance	17	Year	$ 500,000	$ 8,460,000
D. Dredging, Transportation & Placement Costs				***$ 365,909,000***
Mob and Demob	17	Year	$ 2,000,000	$ 33,841,000
Dredging	42.3	Mcy	$ 2.00	$ 84,603,000
Transport	42.3	Mcy	$ 3.60	$ 152,286,000
Placement	42.3	Mcy	$ 2.25	$ 95,179,000
Subtotal Cost A+B+C+D				***$ 567,001,000***
Contingency	15.00%			$ 85,050,000
Total Cost A+B+C+D				***$ 652,051,000***
Total Unit Cost				**$ 15.41**

NOTES:

Total construction cost are based on estimates from Table 6, Borrow Alternative 1

Study cost accounts for conceptual, pre-feasibility and feasibility cost

Dredged material management and costs associated with the lifespan of inflow

Site Maintenance costs are calculated by $150,000+$975/ac and then for an additional 2 years following final inflow

Site monitoring and reporting cost based on costs associated with Poplar Island. Includes Environmental monitoring for operations and 3 years following final placement

Channel construction cost based on excavation of channels within the wetland cells.

It is assumed that the channel dredging will be approximately 2 cy/lf. It is assumed that there will be 250 lf of channel per acre

Planting and seeding esimates based on recent 4D and Notch area plantings for Poplar Island

Mobilization and Demobilization is for the inflow lifespan of the project

Dredging is assumed to be clamshell dredging

Assumed transportation of the material will be $0.10/cy per nautical mile

Placement of the material into the island will be performed by a hydraulic unloader

15 % Contingency assumed to account for unknown factors at this level of study

Unit Rate cost from RSMeans (2002), GBA (2001) and GBA (2002).

Table 14. Total Site Use Cost Analysis for Dike Alignment No. 4 (10 ft)

Basis For Estimate:

Site Capacity (mcy)	34	Site Surface Area (ac)	1520
Site Operating Life (Years)	13	Site Perimeter Dike (ft)	34708
Annual Channel Volume (Cut Yards)	2.5	Site Interior Dikes (ft)	13122
Average One Way Haul Distance (nm)	36	Final Dike Elevation (ft)	10.0

Item	Quantity	Unit	Unit Cost	Item Cost
A. Initial Construction Costs				***$ 64,224,000***
Total Construction Costs				$ 61,224,000
Study Costs				$ 3,000,000
B. Site Development Costs				***$ 67,572,000***
Dredged Material Management	13	Year	$ 1,632,000	$ 21,905,000
Site Maintenance	15	Year	$ 2,242,350	$ 34,582,000
Site Monitoring and Reporting	16	Year	$ 675,000	$ 11,085,000
Subtotal Annual Cost			***4,549,000***	
C. Site Finishing Cost (Habitat Development)				***$ 38,907,000***
Planning and Design	3	Year	$ 1,000,000	$ 3,000,000
Monitoring	13	Year	$ 250,000	$ 3,356,000
Implementation				
Channels	760	Acre	$ 4,000	$ 3,040,000
Planting/Seeding	1,520	Acre	$ 15,000	$ 22,800,000
Operation and Maintenance	13	Year	$ 500,000	$ 6,711,000
D. Dredging, Transportation & Placement Costs				***$ 290,252,000***
Mob and Demob	13	Year	$ 2,000,000	$ 26,844,000
Dredging	33.6	Mcy	$ 2.00	$ 67,110,000
Transport	33.6	Mcy	$ 3.60	$ 120,799,000
Placement	33.6	Mcy	$ 2.25	$ 75,499,000
Subtotal Cost A+B+C+D				***$ 460,955,000***
Contingency	15.00%			$ 69,143,000
Total Cost A+B+C+D				***$ 530,098,000***
Total Unit Cost				**$ 15.80**

NOTES:

Total construction cost are based on estimates from Table 6, Borrow Alternative 1
Study cost accounts for conceptual, pre-feasibility and feasibility cost
Dredged material management and costs associated with the lifespan of inflow
Site Maintenance costs are calculated by $150,000+$975/ac and then for an additional 2 years following final inflow
Site monitoring and reporting cost based on costs associated with Poplar Island. Includes Environmental monitoring for operations and 3 years following final placement
Channel construction cost based on excavation of channels within the wetland cells.
It is assumed that the channel dredging will be approximately 2 cy/lf. It is assumed that there will be 250 lf of channel per acre
Planting and seeding esimates based on recent 4D and Notch area plantings for Poplar Island
Mobilization and Demobilization is for the inflow lifespan of the project
Dredging is assumed to be clamshell dredging
Assumed transportation of the material will be $0.10/cy per nautical mile
Placement of the material into the island will be performed by a hydraulic unloader
15 % Contingency assumed to account for unknown factors at this level of study
Unit Rate cost from RSMeans (2002), GBA (2001) and GBA (2002).

Table 15. Total Site Use Cost Analysis for Dike Alignment No. 4 (20 ft)

Basis For Estimate:

Site Capacity (mcy)	50	Site Surface Area (ac)	1,520
Site Operating Life (Years)	20	Site Perimeter Dike (ft)	34,708
Annual Channel Volume (Cut Yards)	2.5	Site Interior Dikes (ft)	13,125
Average One Way Haul Distance (nm)	36	Final Dike Elevation (ft)	20.0

Item	Quantity	Unit	Unit Cost	Item Cost
A. Initial Construction Costs				***$ 77,200,000***
Total Construction Costs				$ 74,200,000
Study Costs				$ 3,000,000
B. Site Development Costs				***$ 97,324,000***
Dredged Material Management	20	Year	$ 1,632,000	$ 32,577,000
Site Maintenance	22	Year	$ 2,242,485	$ 49,248,000
Site Monitoring and Reporting	23	Year	$ 675,000	$ 15,499,000
Subtotal Annual Cost			***4,549,000***	
C. Site Finishing Cost (Habitat Development)				***$ 43,811,000***
Planning and Design	3	Year	$ 1,000,000	$ 3,000,000
Monitoring	20	Year	$ 250,000	$ 4,990,000
Implementation				
Channels	760	Acre	$ 4,000	$ 3,040,000
Planting/Seeding	1,520	Acre	$ 15,000	$ 22,800,000
Operation and Maintenance	20	Year	$ 500,000	$ 9,981,000
D. Dredging, Transportation & Placement Costs				***$ 431,666,000***
Mob and Demob	20	Year	$ 2,000,000	$ 39,923,000
Dredging	49.9	Mcy	$ 2.00	$ 99,807,000
Transport	49.9	Mcy	$ 3.60	$ 179,653,000
Placement	49.9	Mcy	$ 2.25	$ 112,283,000
Subtotal Cost A+B+C+D				***$ 650,001,000***
Contingency	15.00%			$ 97,500,000
Total Cost A+B+C+D				***$ 747,501,000***
Total Unit Cost				**$ 14.98**

NOTES:

Total construction cost are based on estimates from Table 6, Borrow Alternative 1

Study cost accounts for conceptual, pre-feasibility and feasibility cost

Dredged material management and costs associated with the lifespan of inflow

Site Maintenance costs are calculated by $150,000+$975/ac and then for an additional 2 years following final inflow

Site monitoring and reporting cost based on costs associated with Poplar Island. Includes Environmental monitoring for operations and 3 years following final placement

Channel construction cost based on excavation of channels within the wetland cells.
It is assumed that the channel dredging will be approximately 2 cy/lf. It is assumed that there will be 250 lf of channel per acre

Planting and seeding esimates based on recent 4D and Notch area plantings for Poplar Island

Mobilization and Demobilization is for the inflow lifespan of the project

Dredging is assumed to be clamshell dredging

Assumed transportation of the material will be $0.10/cy per nautical mile

Placement of the material into the island will be performed by a hydraulic unloader

15 % Contingency assumed to account for unknown factors at this level of study

Unit Rate cost from RSMeans (2002), GBA (2001) and GBA (2002).

Table 16. Total site use cost analysis for Dike Alignment No. 5 (10 ft)

Basis For Estimate:

Site Capacity (mcy)	25	Site Surface Area (ac)	1,070
Site Operating Life (Years)	10	Site Perimeter Dike (ft)	41,653
Annual Channel Volume (Cut Yards)	2.5	Site Interior Dikes (ft)	4,320
Average One Way Haul Distance (nm)	36	Final Dike Elevation (ft)	10.0

Item	Quantity	Unit	Unit Cost	Item Cost
A. Initial Construction Costs				***$ 84,268,000***
Total Construction Costs				$ 81,268,000
Study Costs				$ 3,000,000
B. Site Development Costs				***$ 46,617,000***
Dredged Material Management	10	Year	$ 1,193,250	$ 11,934,000
Site Maintenance	12	Year	$ 2,158,785	$ 25,907,000
Site Monitoring and Reporting	13	Year	$ 675,000	$ 8,776,000
Subtotal Annual Cost			***4,027,000***	
C. Site Finishing Cost (Habitat Development)				***$ 28,690,000***
Planning and Design	3	Year	$ 1,000,000	$ 3,000,000
Monitoring	10	Year	$ 250,000	$ 2,500,000
Implementation				
Channels	535	Acre	$ 4,000	$ 2,140,000
Planting/Seeding	1,070	Acre	$ 15,000	$ 16,050,000
Operation and Maintenance	10	Year	$ 500,000	$ 5,000,000
D. Dredging, Transportation & Placement Costs				***$ 216,269,000***
Mob and Demob	10	Year	$ 2,000,000	$ 20,002,000
Dredging	25.0	Mcy	$ 2.00	$ 50,004,000
Transport	25.0	Mcy	$ 3.60	$ 90,008,000
Placement	25.0	Mcy	$ 2.25	$ 56,255,000
Subtotal Cost A+B+C+D				***$ 375,844,000***
Contingency	15.00%			$ 56,377,000
Total Cost A+B+C+D				***$ 432,221,000***
Total Unit Cost				**$ 17.29**

NOTES:

Total construction cost are based on estimates from Table 6, Borrow Alternative 1
Study cost accounts for conceptual, pre-feasibility and feasibility cost
Dredged material management and costs associated with the lifespan of inflow
Site Maintenance costs are calculated by $150,000+$975/ac and then for an additional 2 years following final inflow
Site monitoring and reporting cost based on costs associated with Poplar Island. Includes Environmental monitoring for operations and 3 years following final placement
Channel construction cost based on excavation of channels within the wetland cells.
It is assumed that the channel dredging will be approximately 2 cy/lf. It is assumed that there will be 250 lf of channel per acre
Planting and seeding esimates based on recent 4D and Notch area plantings for Poplar Island
Mobilization and Demobilization is for the inflow lifespan of the project
Dredging is assumed to be clamshell dredging
Assumed transportation of the material will be $0.10/cy per nautical mile
Placement of the material into the island will be performed by a hydraulic unloader
15 % Contingency assumed to account for unknown factors at this level of study
Unit Rate cost from RSMeans (2002), GBA (2001) and GBA (2002).

Table 17. Total site use cost analysis for Dike Alignment No. 5 (20 ft)

Basis For Estimate:

Site Capacity (mcy)	37	Site Surface Area (ac)	1,070
Site Operating Life (Years)	15	Site Perimeter Dike (ft)	41,653
Annual Channel Volume (Cut Yards)	2.5	Site Interior Dikes (ft)	3,475
Average One Way Haul Distance (nm)	36	Final Dike Elevation (ft)	20.0

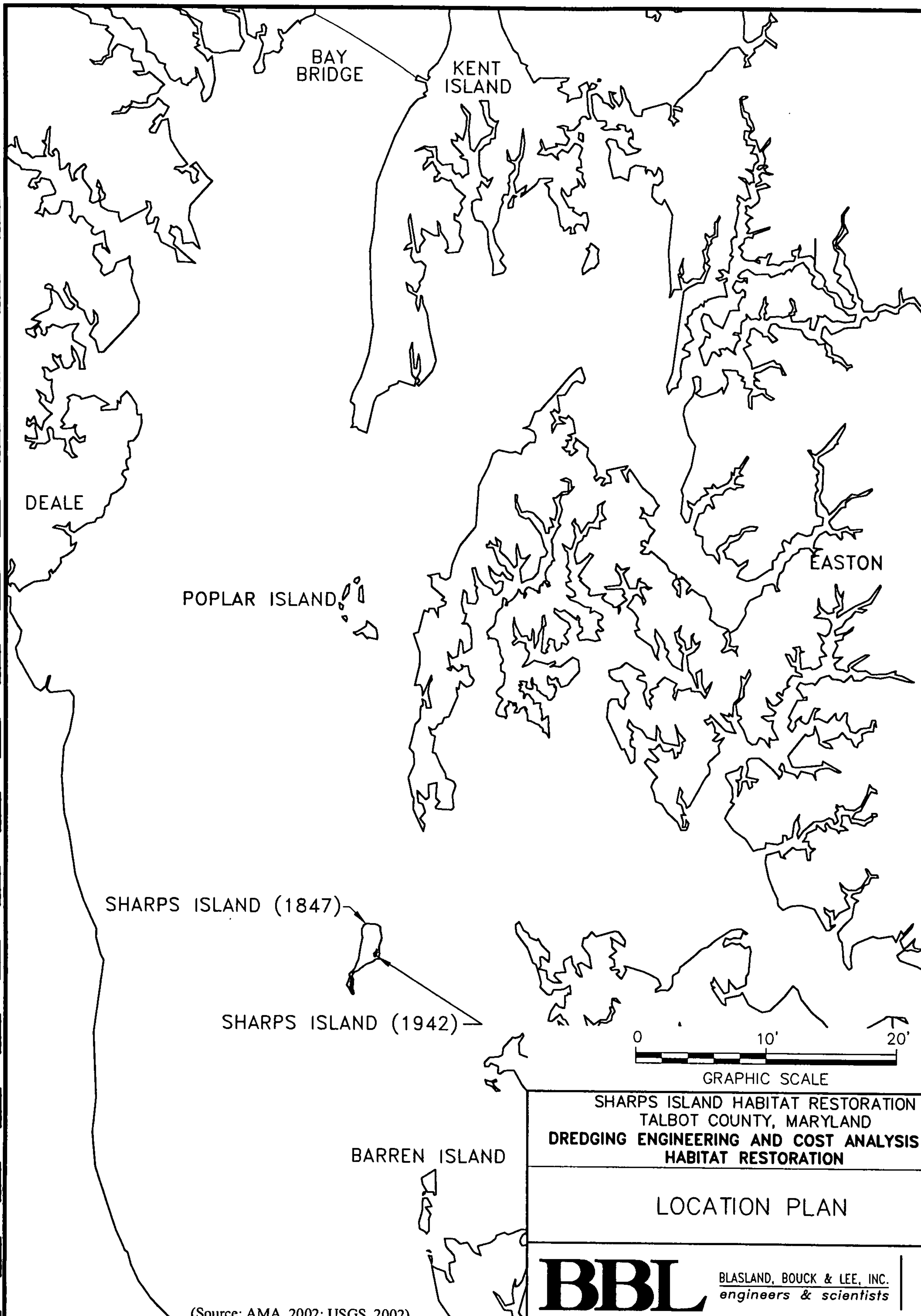
Item	Quantity	Unit	Unit Cost	Item Cost
A. Initial Construction Costs				***$ 90,841,000***
Total Construction Costs				$ 87,841,000
Study Costs				$ 3,000,000
B. Site Development Costs				***$ 64,523,000***
Dredged Material Management	15	Year	$ 1,193,250	$ 17,426,000
Site Maintenance	17	Year	$ 2,120,760	$ 35,214,000
Site Monitoring and Reporting	18	Year	$ 675,000	$ 11,883,000
Subtotal Annual Cost			***3,989,000***	
C. Site Finishing Cost (Habitat Development)				***$ 32,143,000***
Planning and Design	3	Year	$ 1,000,000	$ 3,000,000
Monitoring	15	Year	$ 250,000	$ 3,651,000
Implementation				
Channels	535	Acre	$ 4,000	$ 2,140,000
Planting/Seeding	1,070	Acre	$ 15,000	$ 16,050,000
Operation and Maintenance	15	Year	$ 500,000	$ 7,302,000
D. Dredging, Transportation & Placement Costs				***$ 315,816,000***
Mob and Demob	15	Year	$ 2,000,000	$ 29,208,000
Dredging	36.5	Mcy	$ 2.00	$ 73,021,000
Transport	36.5	Mcy	$ 3.60	$ 131,438,000
Placement	36.5	Mcy	$ 2.25	$ 82,149,000
Subtotal Cost A+B+C+D				***$ 503,323,000***
Contingency	15.00%			$ 75,498,000
Total Cost A+B+C+D				***$ 578,821,000***
Total Unit Cost				**$ 15.85**

NOTES:

Total construction cost are based on estimates from Table 6, Borrow Alternative 1
Study cost accounts for conceptual, pre-feasibility and feasibility cost
Dredged material management and costs associated with the lifespan of inflow
Site Maintenance costs are calculated by $150,000+$975/ac and then for an additional 2 years following final inflow
Site monitoring and reporting cost based on costs associated with Poplar Island. Includes Environmental monitoring for operations and 3 years following final placement
Channel construction cost based on excavation of channels within the wetland cells.
It is assumed that the channel dredging will be approximately 2 cy/lf. It is assumed that there will be 250 lf of channel per acre
Planting and seeding esimates based on recent 4D and Notch area plantings for Poplar Island
Mobilization end Demobilization is for the inflow lifespan of the project
Dredging is assumed to be clamshell dredging
Assumed transportation of the material will be $0.10/cy per nautical mile
Placement of the material into the island will be performed by a hydraulic unloader
15 % Contingency assumed to account for unknown factors at this level of study
Unit Rate cost from RSMeans (2002), GBA (2001) and GBA (2002).

Figures

BLASLAND, BOUCK & LEE, INC.
engineers & scientists



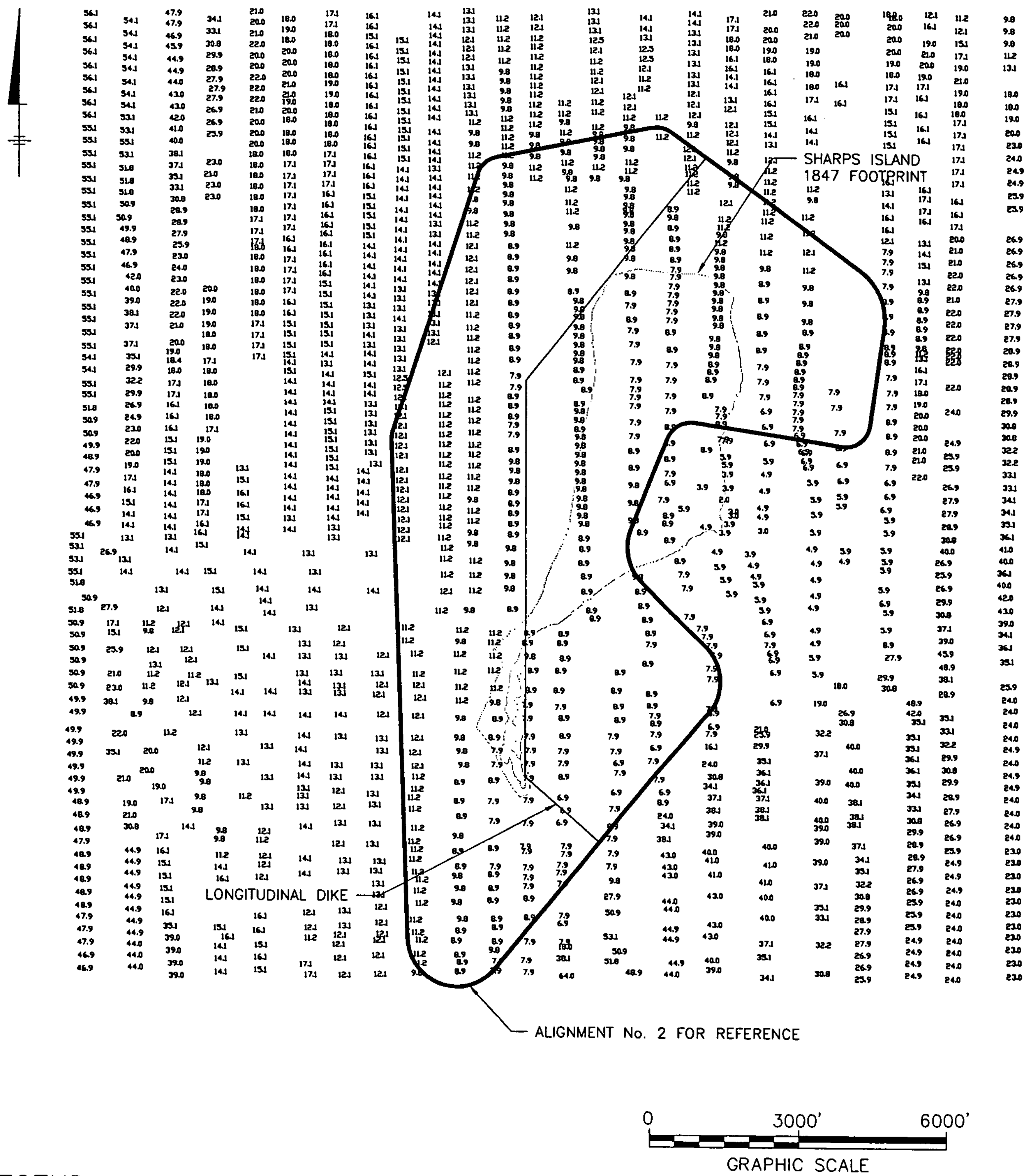
SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND

DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

LOCATION PLAN

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 1



LEGEND

———	PERIMETER DIKE (ALIGNMENT 2)
——	LONGITUDINAL DIKE
17.1	WATER DEPTH
······	SHARPS ISLAND 1847 FOOTPRINT
— —	NATURAL OYSTER BAR No. 14–4

(Source: AMA, 2002; E2CR, 2002)

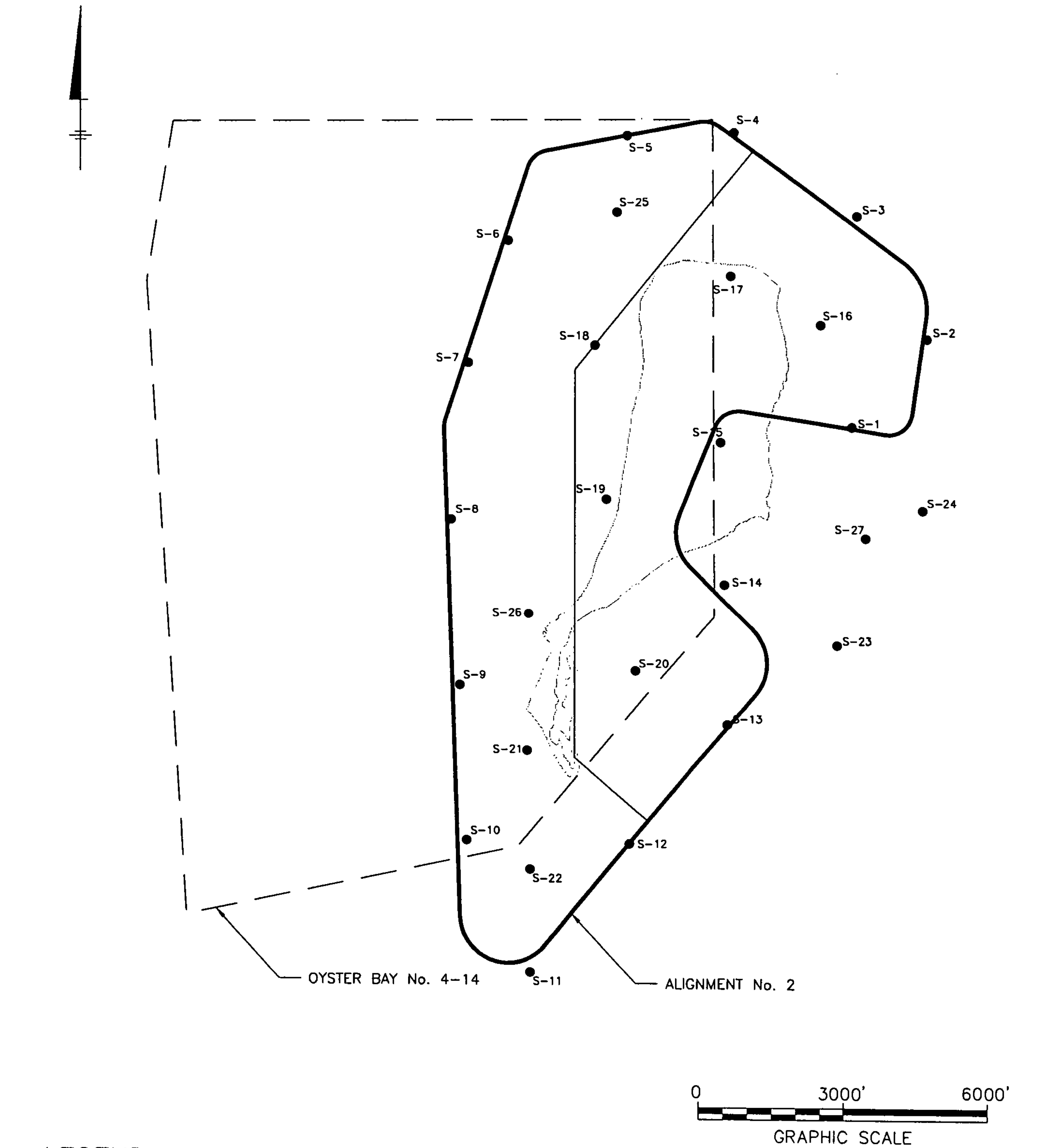
SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND

DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

BATHYMETRY PLAN

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 2



LEGEND

- PERIMETER DIKE
- LONGITUDINAL DIKE
- S-22 ● BORING (E2CR, 2002)
- SHARPS ISLAND 1847 FOOTPRINT
- NATURAL OYSTER BAR No. 14-4

(Source: AMA, 2002; E2CR, 2002)

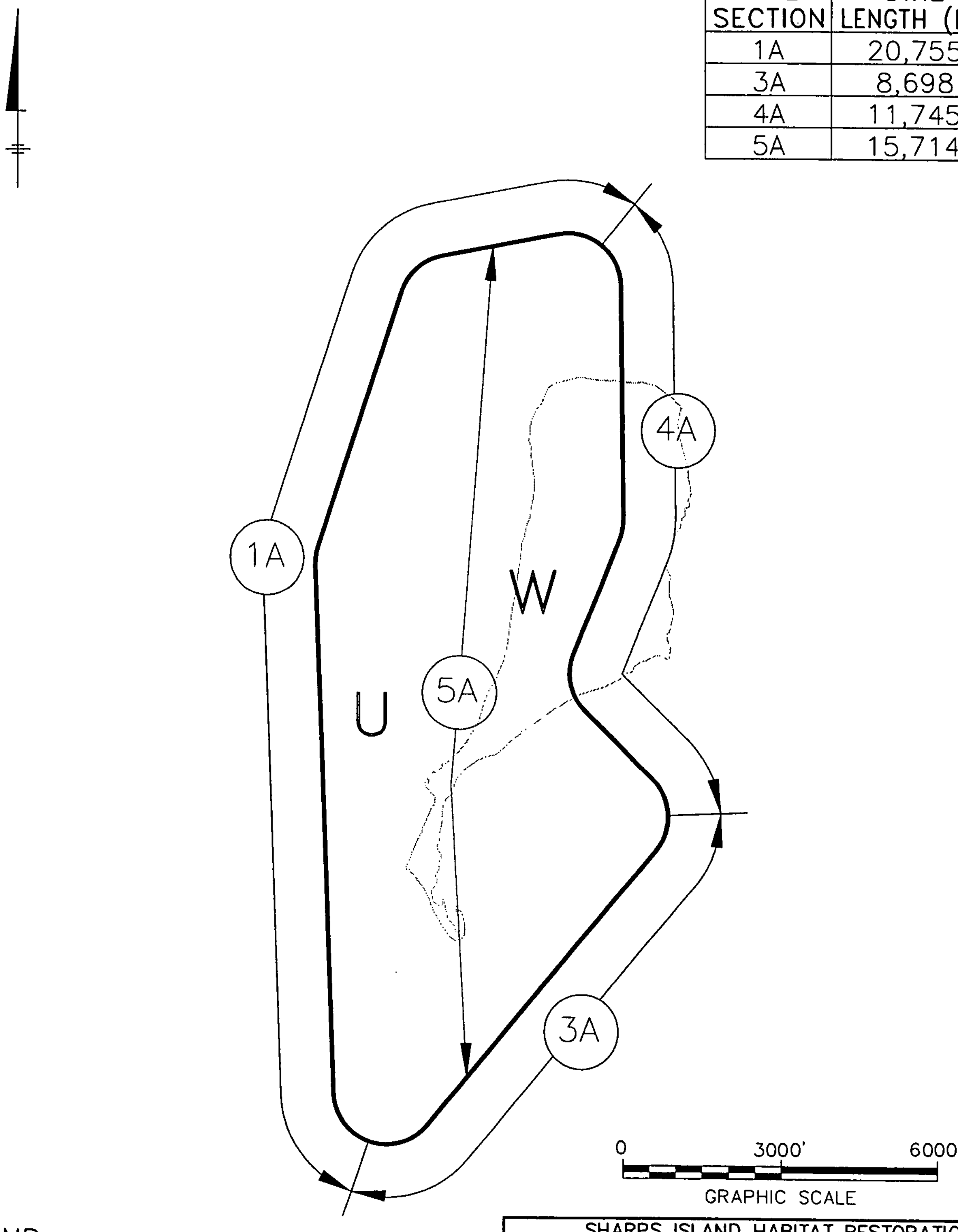
SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

BORING LOCATION PLAN

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 3

DIKE SECTION	DIKE LENGTH (FT)
1A	20,755
3A	8,698
4A	11,745
5A	15,714



LEGEND
U UPLAND – 920 Ac.
W WETLAND – 920 Ac.
PERIMETER DIKE
LONGITUDINAL DIKE
3A TYPICAL DIKE SECTION
SHARPS ISLAND 1847 FOOTPRINT

Modified from AMA, 2002

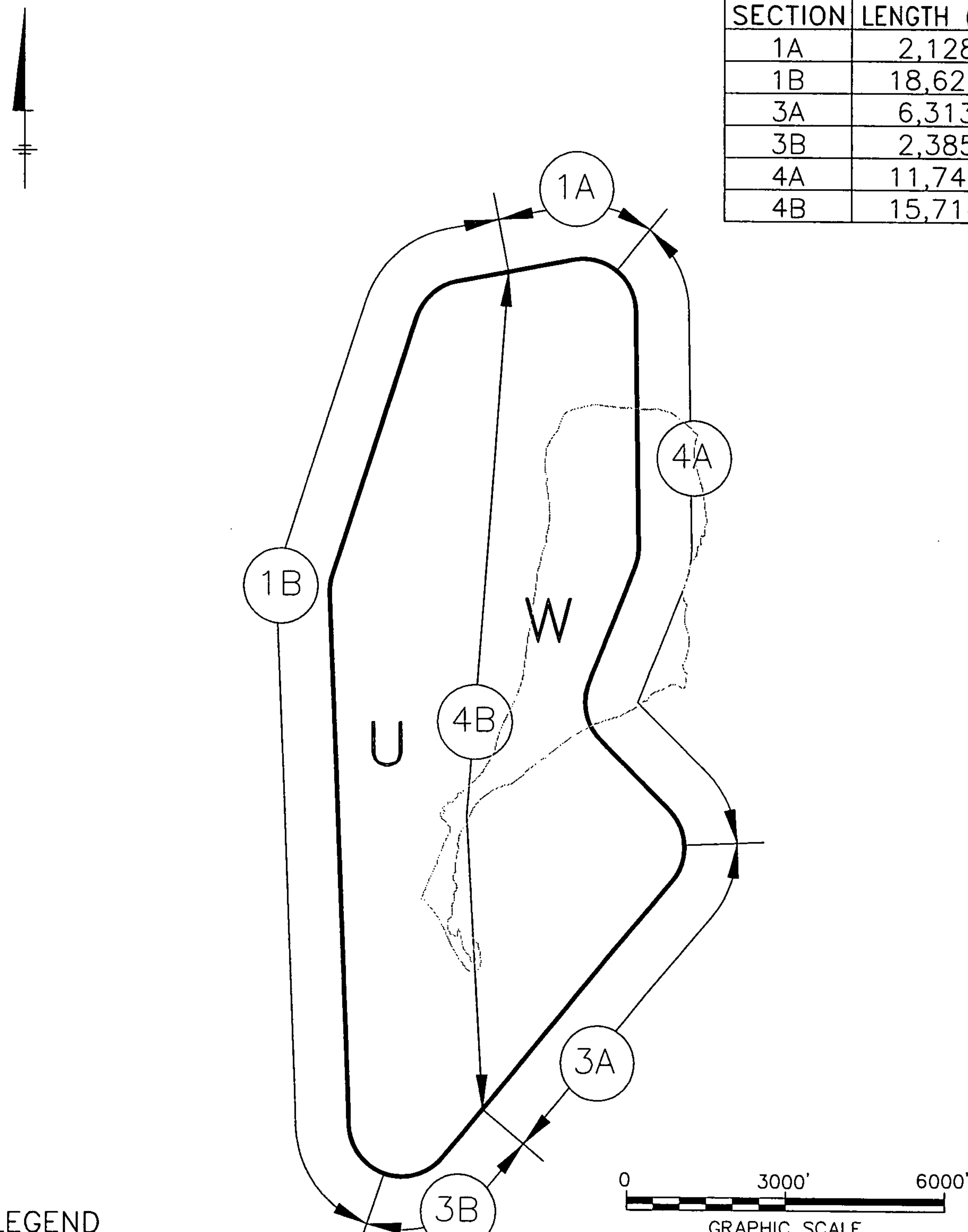
SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

DIKE ALIGNMENT No. 1 – 10 FT

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 4

DIKE SECTION	DIKE LENGTH (FT)
1A	2,128
1B	18,627
3A	6,313
3B	2,385
4A	11,745
4B	15,714



LEGEND

U UPLAND – 920 Ac.
W WETLAND – 920 Ac.
PERIMETER DIKE
LONGITUDINAL DIKE
3A TYPICAL DIKE SECTION
SHARPS ISLAND 1847 FOOTPRINT

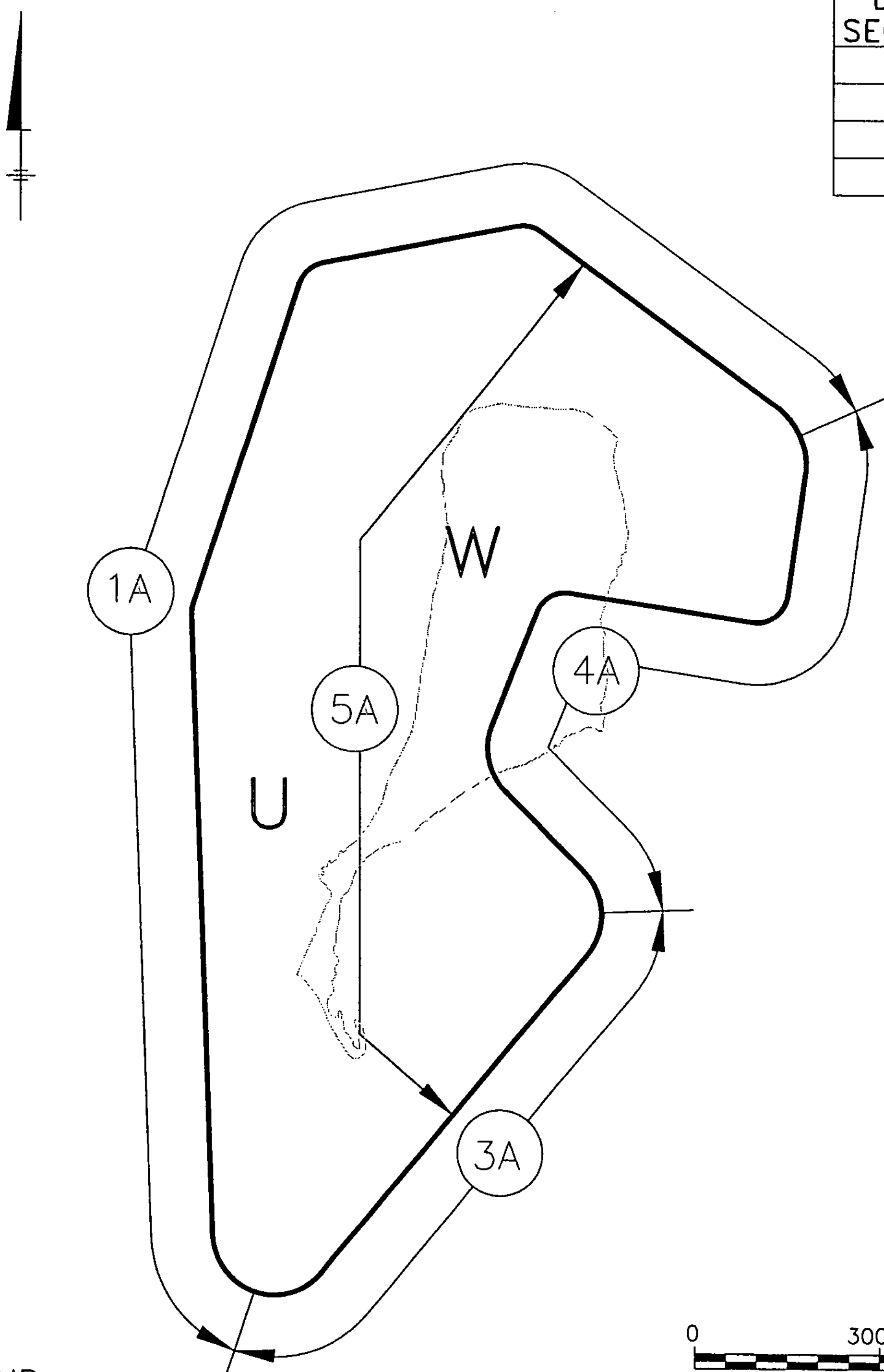
Modified from AMA, 2002

SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

DIKE ALIGNMENT No. 1 – 20 FT

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 5



DIKE SECTION	DIKE LENGTH (FT)
1A	26,408
3A	7,545
4A	12,845
5A	15,775

LEGEND
U UPLAND – 1,130 Ac.
W WETLAND – 1,130 Ac.
PERIMETER DIKE
LONGITUDINAL DIKE
3A TYPICAL DIKE SECTION
SHARPS ISLAND 1847 FOOTPRINT

Modified from AMA, 2002

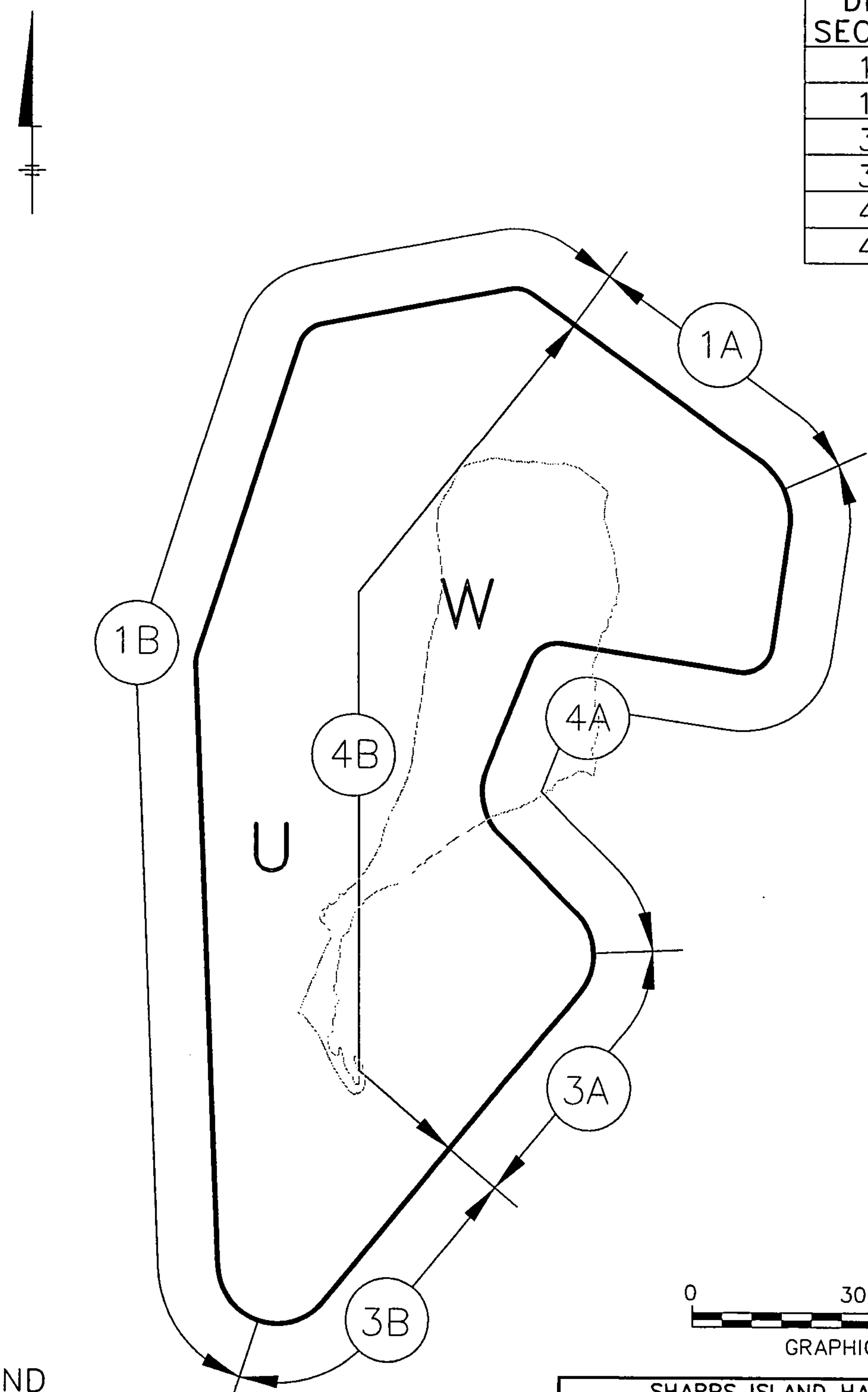
SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

DIKE ALIGNMENT No. 2 – 10 FT

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 6

DIKE SECTION	DIKE LENGTH (FT)
1A	4,481
1B	21,927
3A	4,146
3B	3,399
4A	12,845
4B	15,775



0 3000' 6000'

GRAPHIC SCALE

LEGEND

U UPLAND – 1,130 Ac.
W WETLAND – 1,130 Ac.
PERIMETER DIKE
LONGITUDINAL DIKE
3A TYPICAL DIKE SECTION
SHARPS ISLAND 1847 FOOTPRINT

Modified from AMA, 2002

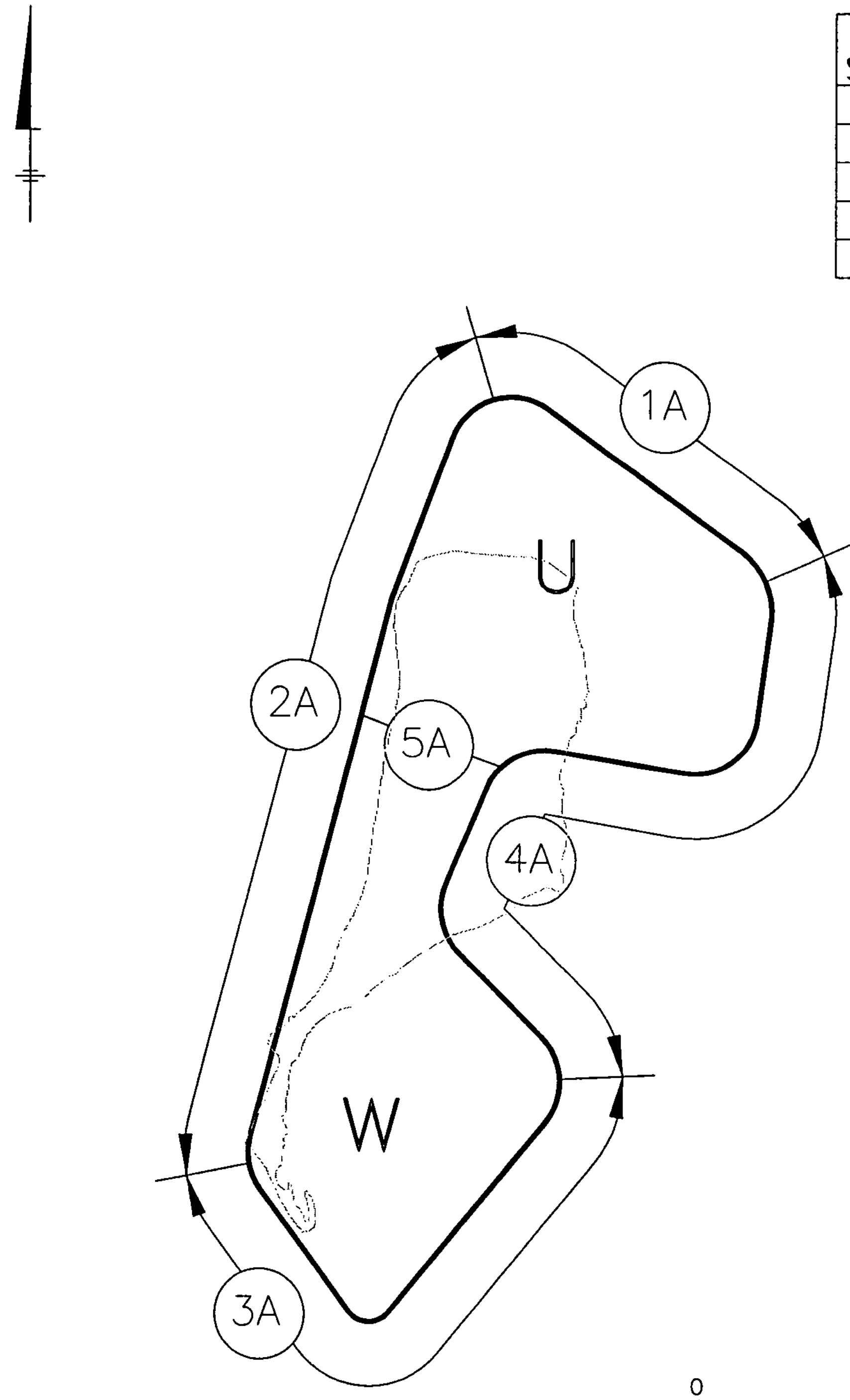
SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

DIKE ALIGNMENT No. 2 – 20 FT

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 7

DIKE SECTION	DIKE LENGTH (FT)
1A	5,277
2A	12,731
3A	8,084
4A	12,531
5A	2,350



0 3000' 6000'

GRAPHIC SCALE

LEGEND

U UPLAND – 600 Ac.

W WETLAND – 600 Ac.

PERIMETER DIKE

LONGITUDINAL DIKE

(3A) TYPICAL DIKE SECTION

SHARPS ISLAND 1847 FOOTPRINT

Modified from AMA, 2002

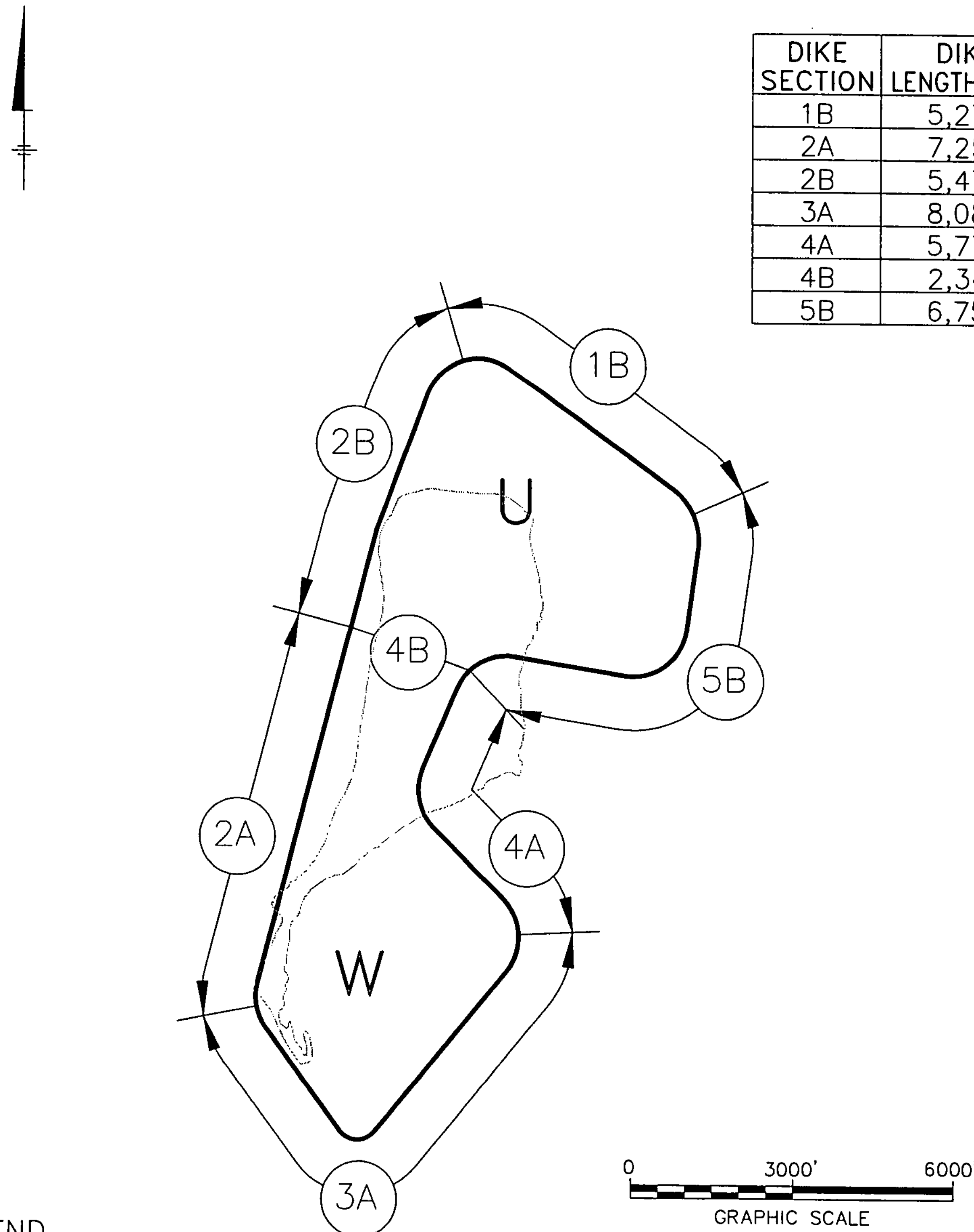
SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

DIKE ALIGNMENT No. 3 – 10 FT

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 8

DIKE SECTION	DIKE LENGTH (FT)
1B	5,275
2A	7,252
2B	5,478
3A	8,084
4A	5,778
4B	2,349
5B	6,753



LEGEND
U UPLAND – 600 Ac.
W WETLAND – 600 Ac.
PERIMETER DIKE
LONGITUDINAL DIKE
(3A) TYPICAL DIKE SECTION
SHARPS ISLAND 1847 FOOTPRINT

Modified from AMA, 2002

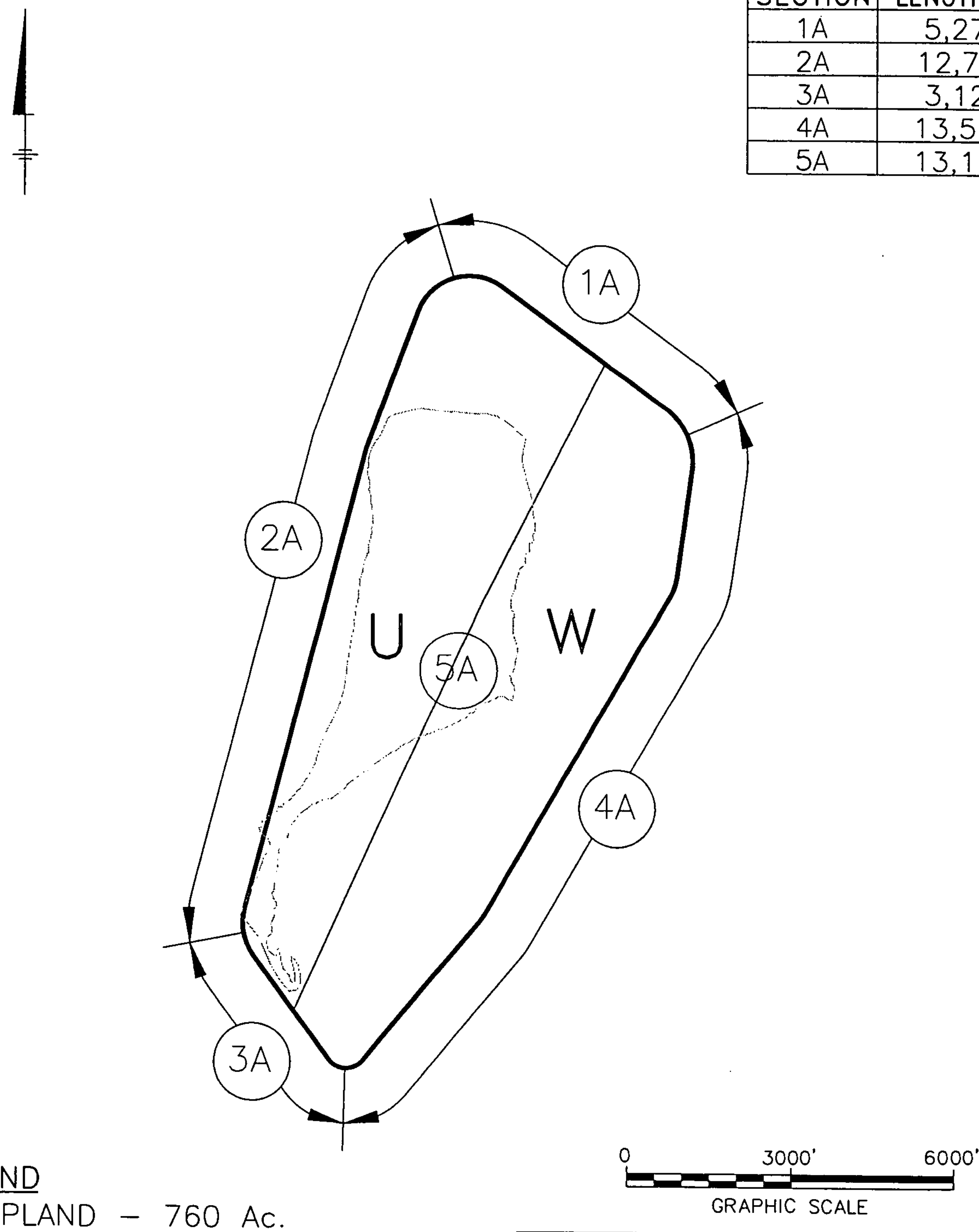
SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

DIKE ALIGNMENT No. 3 – 20 FT

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 9

DIKE SECTION	DIKE LENGTH–FT
1A	5,277
2A	12,731
3A	3,129
4A	13,572
5A	13,122



LEGEND
U UPLAND – 760 Ac.
W WETLAND – 760 Ac.
PERIMETER DIKE
LONGITUDINAL DIKE
(3A) TYPICAL DIKE SECTION
SHARPS ISLAND 1847 FOOTPRINT

SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

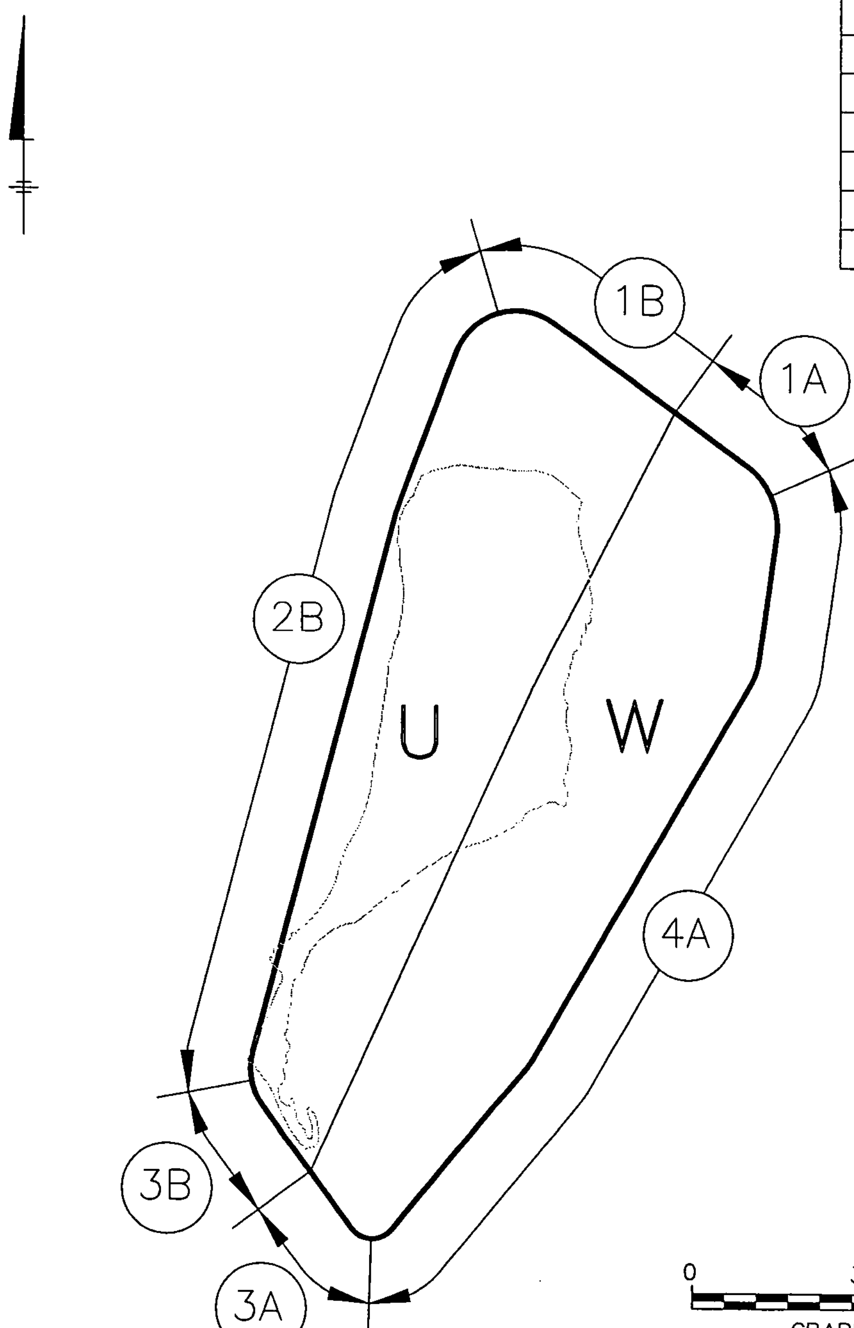
DIKE ALIGNMENT No. 4 – 10 FT

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 10

Modified from AMA, 2002

DIKE SECTION	DIKE LENGTH (FT)
1A	2,000
1B	3,274
2B	12,731
3A	1,443
3B	1,686
4A	13,572
4B	13,125



0 3000' 6000'
GRAPHIC SCALE

LEGEND
U UPLAND – 760 Ac.
W WETLAND – 760 Ac.
PERIMETER DIKE
LONGITUDINAL DIKE
(3A) TYPICAL DIKE SECTION
SHARPS ISLAND 1847 FOOTPRINT

SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

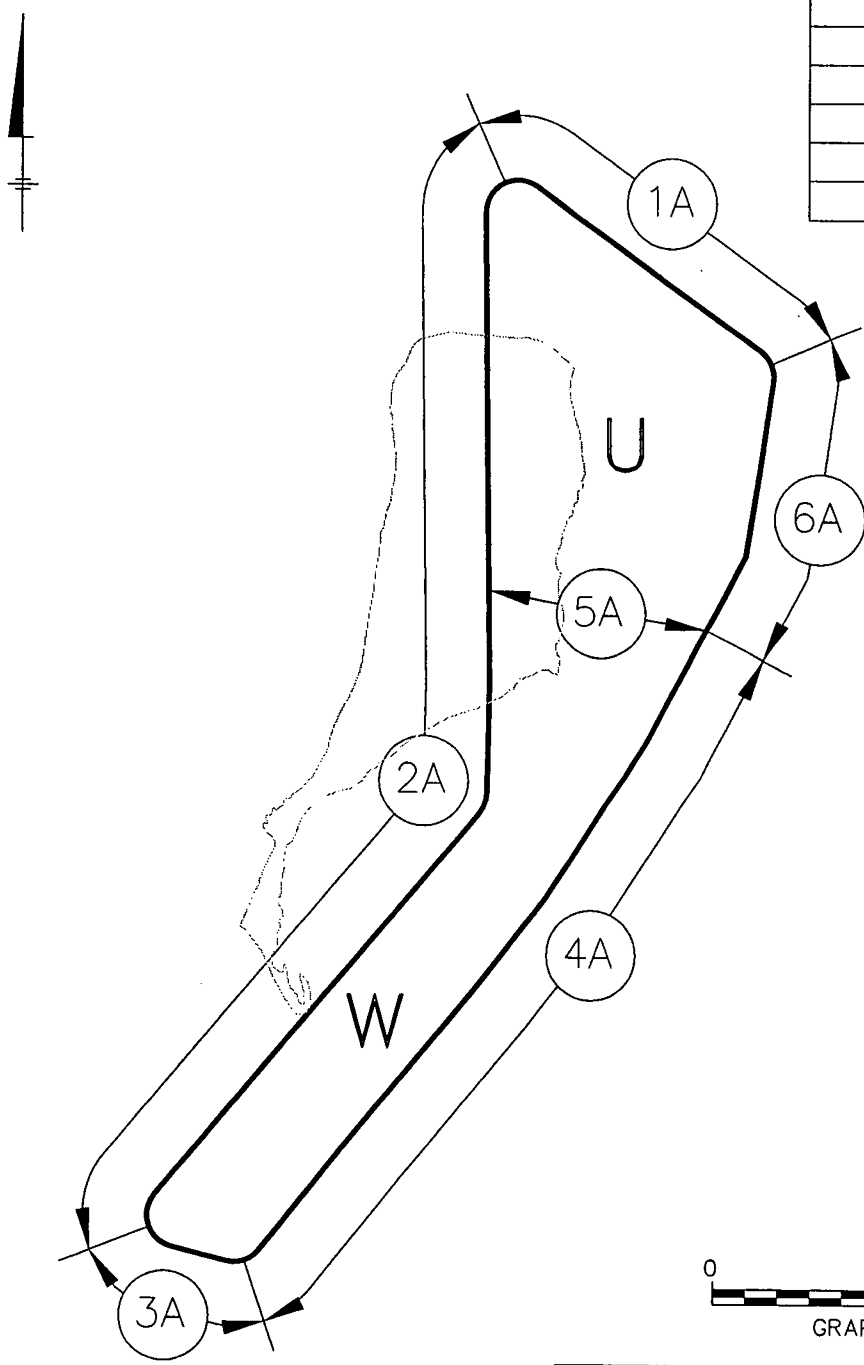
DIKE ALIGNMENT No. 4 – 20 FT

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 11

Modified from AMA, 2002

DIKE SECTION	DIKE LENGTH (FT)
1A	5,124
2A	18,297
3A	1,648
4A	12,262
5A	3,475
6A	4,320



LEGEND

U UPLAND – 535 Ac.
W WETLAND – 535 Ac.
PERIMETER DIKE
LONGITUDINAL DIKE
(3A) TYPICAL DIKE SECTION
SHARPS ISLAND 1847 FOOTPRINT

Modified from AMA, 2002

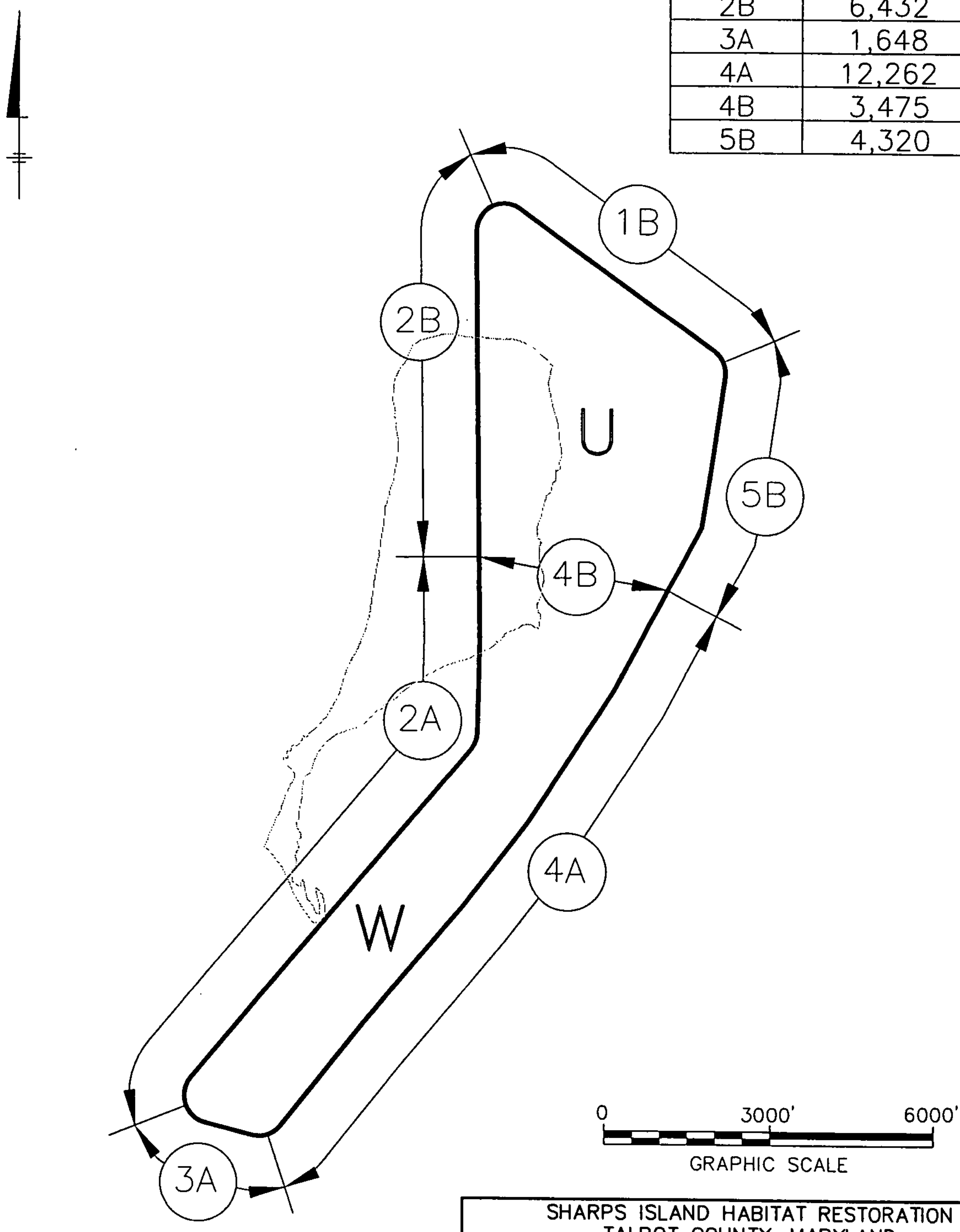
SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

DIKE ALIGNMENT No. 5 – 10 FT

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 12

DIKE SECTION	DIKE LENGTH (FT)
1B	5,124
2A	11,865
2B	6,432
3A	1,648
4A	12,262
4B	3,475
5B	4,320



LEGEND

U UPLAND – 535 Ac.

W WETLAND – 535 Ac.

PERIMETER DIKE

LONGITUDINAL DIKE

(3A) TYPICAL DIKE SECTION

SHARPS ISLAND 1847 FOOTPRINT

Modified from AMA, 2002

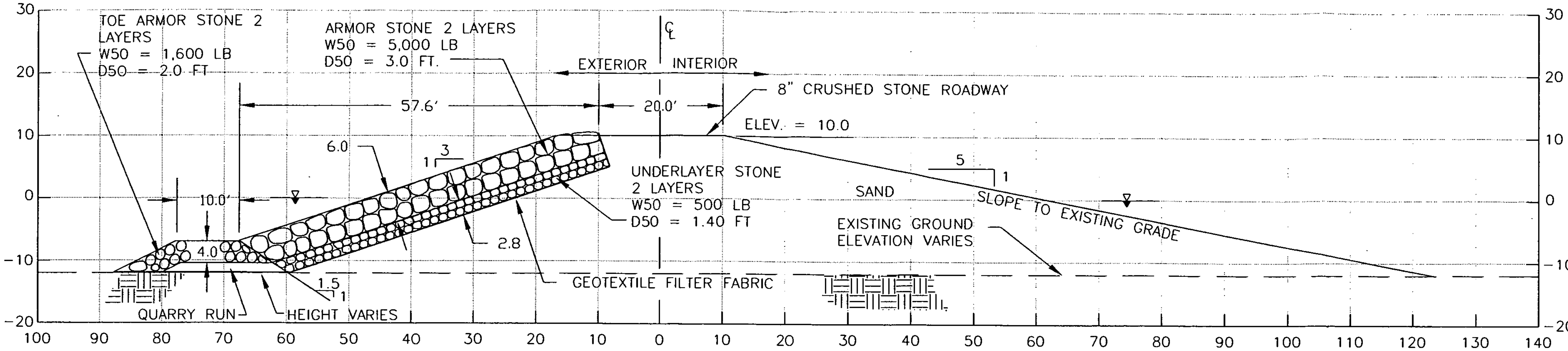
SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND

DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

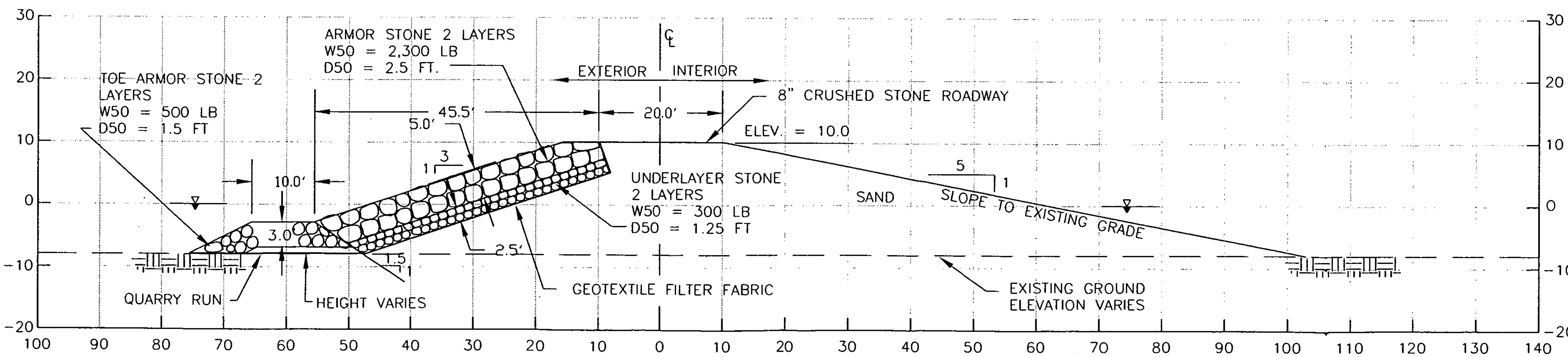
DIKE ALIGNMENT No. 5 – 20 FT

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 13



TYPICAL DIKE SECTION No. 1A
SCALE: 1" = 20'



TYPICAL DIKE SECTION No. 2A
SCALE: 1" = 20'

0 20' 40'
GRAPHIC SCALE

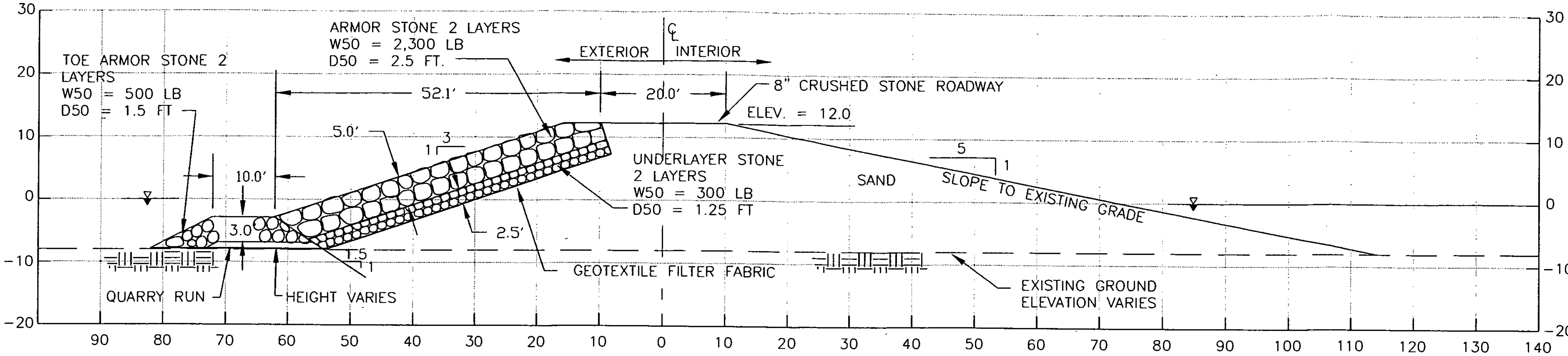
Modified from AMA, 2002

SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

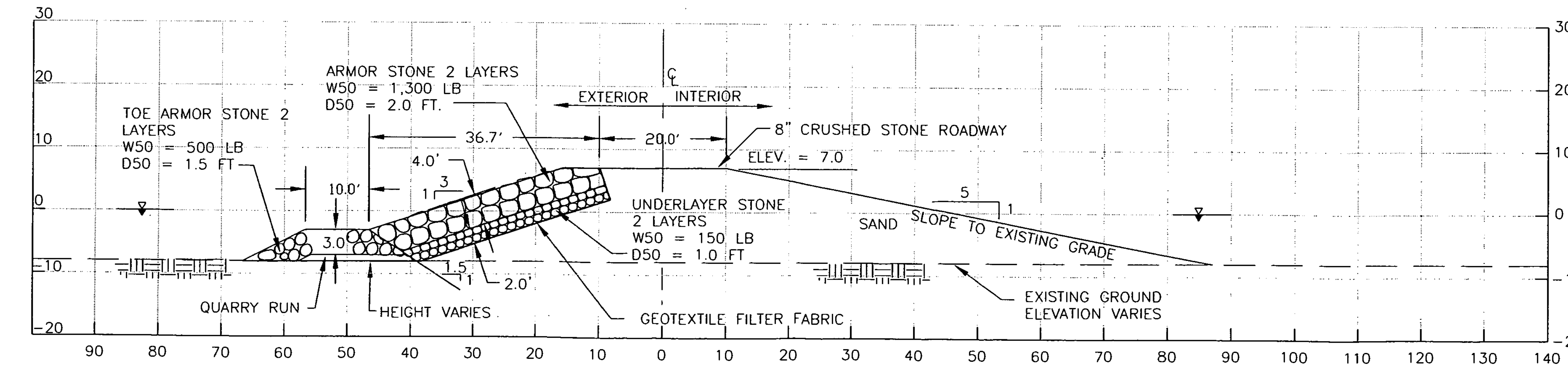
TYPICAL DIKE SECTIONS
No. 1A AND No. 2A

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 14

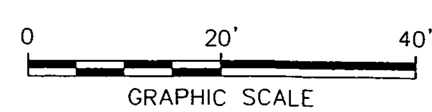


TYPICAL DIKE SECTION No. 3A
SCALE: 1" = 20'



TYPICAL DIKE SECTION No. 4A
SCALE: 1" = 20'

Modified from AMA, 2002

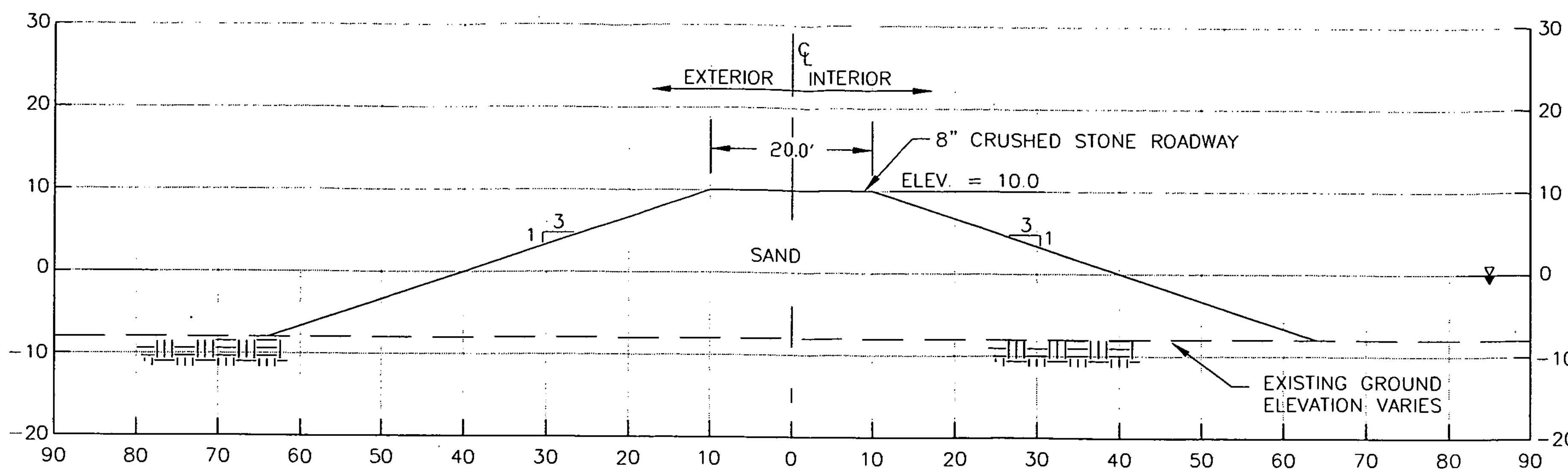


SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

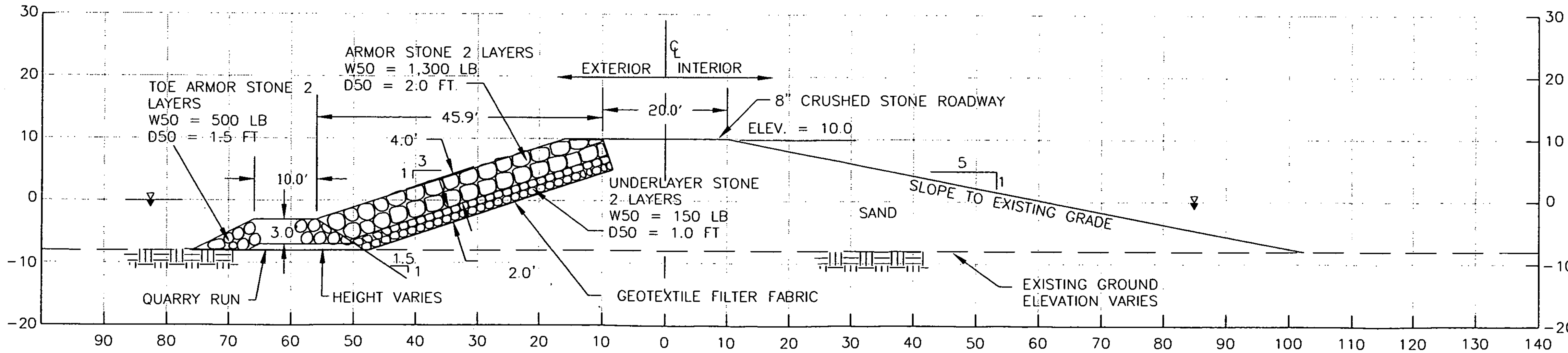
TYPICAL DIKE SECTIONS
No. 3A AND No. 4A

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 15

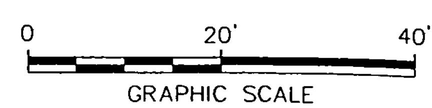


TYPICAL DIKE SECTION No. 5A
SCALE: 1" = 20'



TYPICAL DIKE SECTION No. 6A
SCALE: 1" = 20'

Modified from AMA, 2002

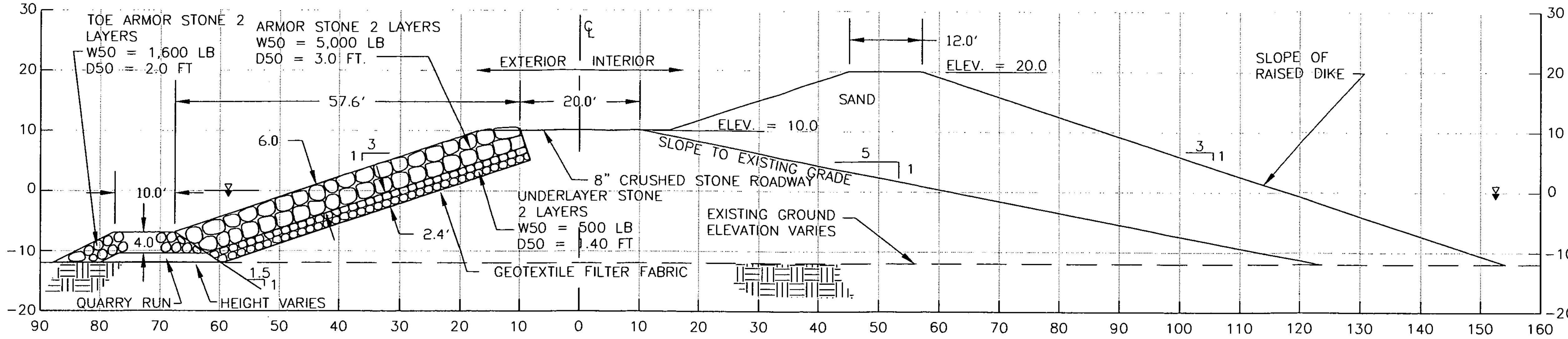


SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

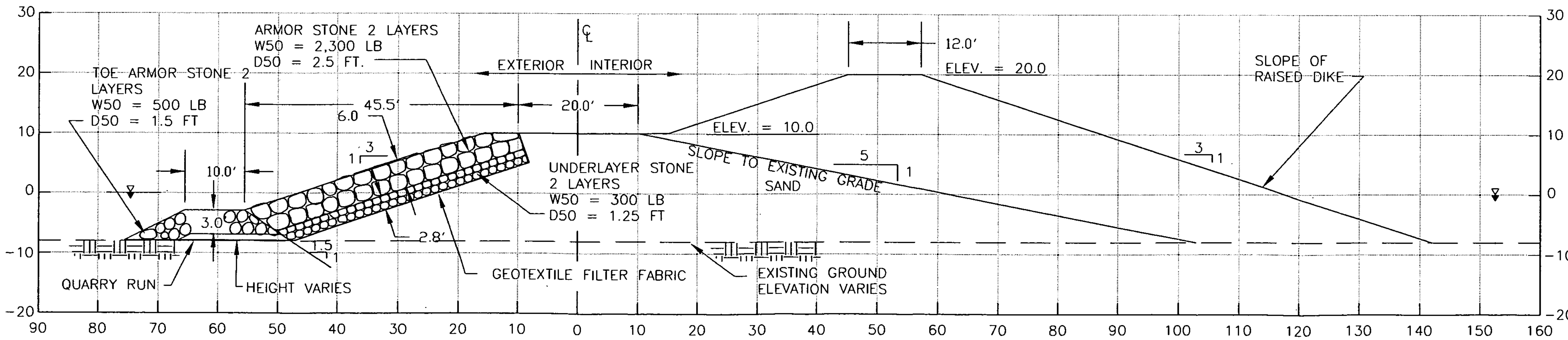
TYPICAL DIKE SECTIONS
No. 5A AND No. 6A

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 16



TYPICAL DIKE SECTION No. 1B
SCALE: 1" = 20'



TYPICAL DIKE SECTION No. 2B
SCALE: 1" = 20'

0 20' 40'
GRAPHIC SCALE

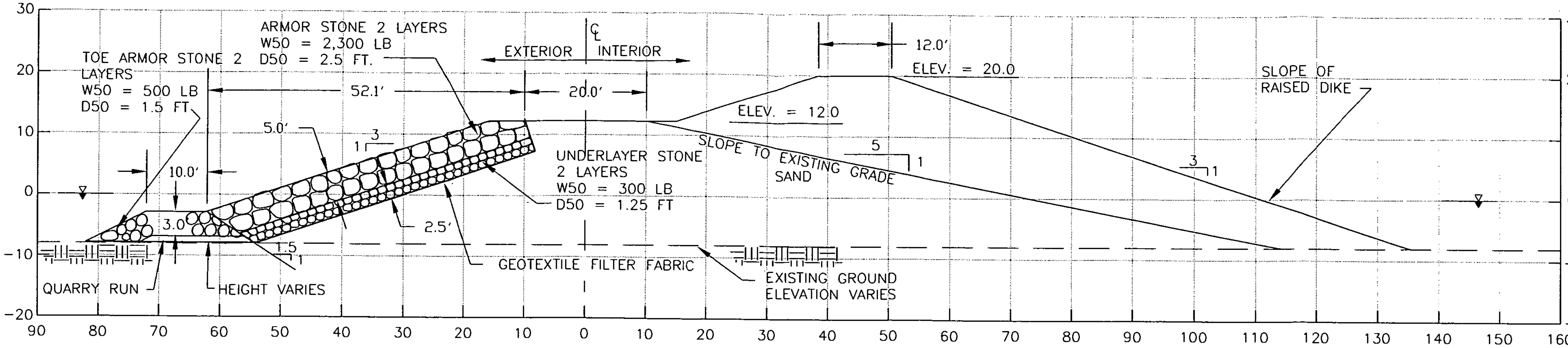
Modified from AMA, 2002

SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

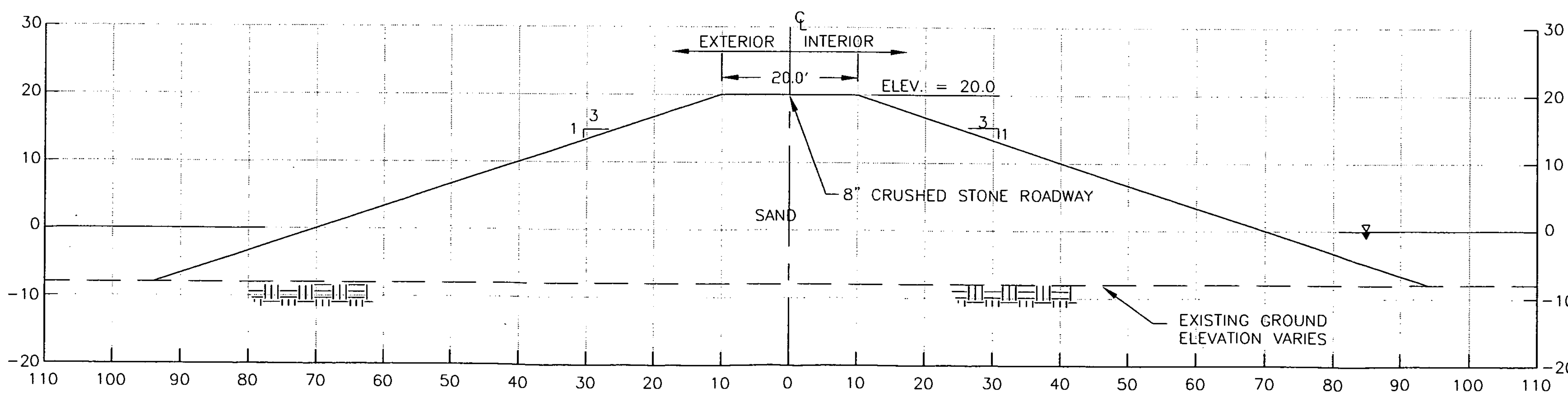
TYPICAL DIKE SECTIONS
No. 1B AND No. 2B

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 17



TYPICAL DIKE SECTION No. 3B
SCALE: 1" = 20'



TYPICAL DIKE SECTION No. 4B
SCALE: 1" = 20'

0 20' 40'
GRAPHIC SCALE

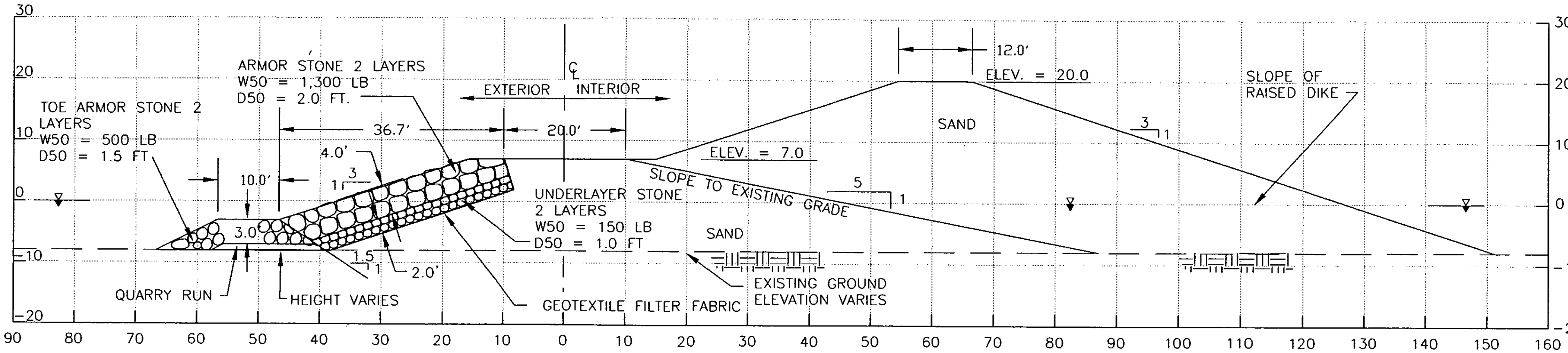
Modified from AMA, 2002

SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

TYPICAL DIKE SECTIONS
No. 3B AND No. 4B

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 18



TYPICAL DIKE SECTION No. 5B
SCALE: 1" = 20'

GRAPHIC SCALE 0 20' 40'

Modified from AMA, 2002

SHARPS ISLAND HABITAT RESTORATION
TALBOT COUNTY, MARYLAND
DREDGING ENGINEERING AND COST ANALYSIS FOR HABITAT RESTORATION

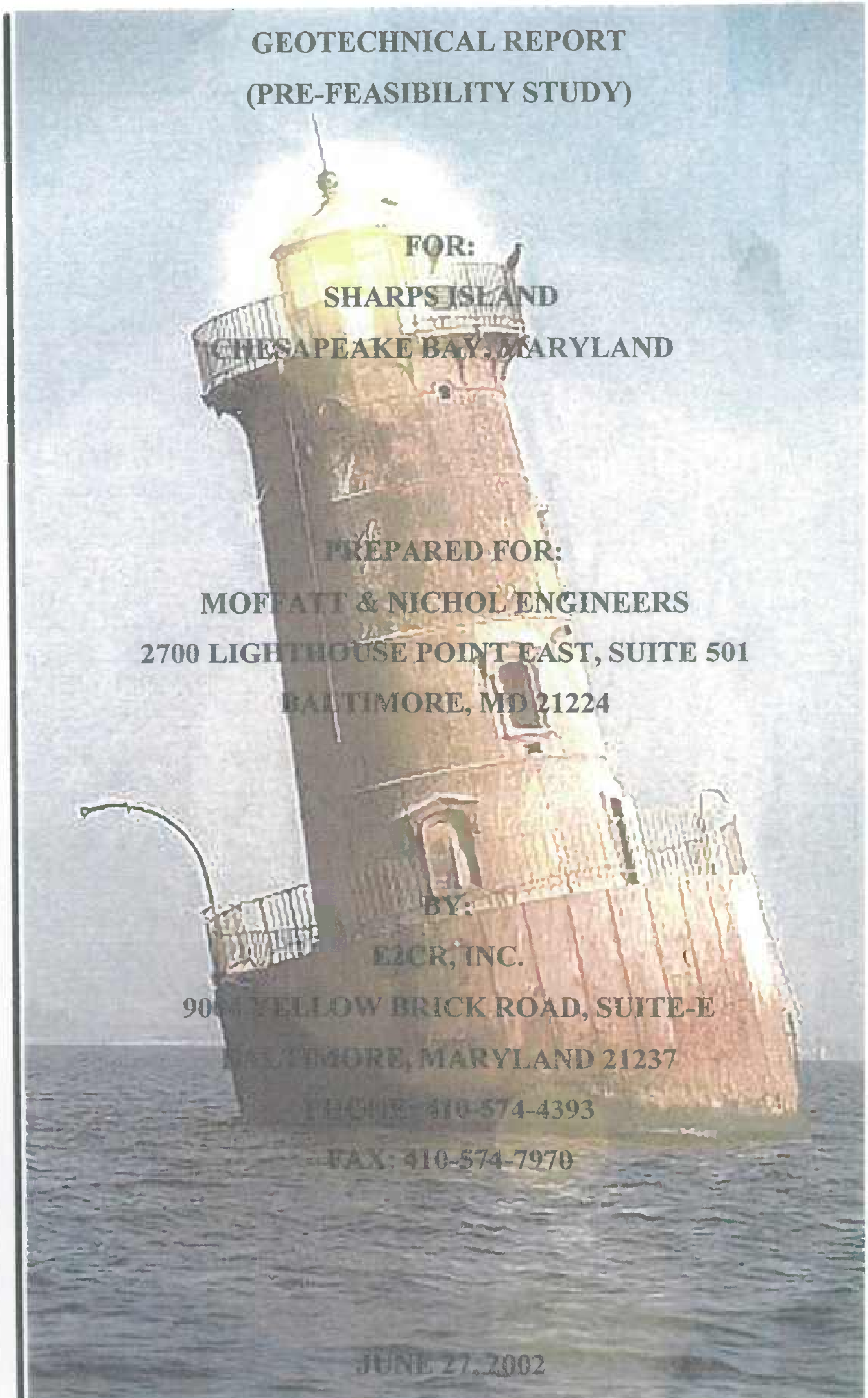
TYPICAL DIKE SECTION
No. 5B

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 19

APPENDIX C

GEOTECHNICAL REPORT



GEOTECHNICAL REPORT
(PRE-FEASIBILITY STUDY)

FOR:

SHARPS ISLAND

CHESAPEAKE BAY, MARYLAND

PREPARED FOR:

MOFFATT & NICHOL ENGINEERS

2700 LIGHTHOUSE POINT EAST, SUITE 501

BALTIMORE, MD 21224

BY:

E2CR, INC.

90[illegible] YELLOW BRICK ROAD, SUITE-E

BALTIMORE, MARYLAND 21237

PHONE: 410-574-4393

FAX: 410-574-7970

JUNE 27, 2002

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E/2 C/R inc.
CONSTRUCTION • REMEDIATION •

9004 Yellow Brick Road, Suite E
Baltimore, Maryland 21237
Phone: 410-574-4393
Fax: 410-574-7970
e-mail: e2cr@erols.com

June 27, 2002

Mr. Pete Kotulak, P.E.
Moffatt & Nichol Engineers
2700 Lighthouse Point East, Suite 501
Baltimore, MD 21224

Re: Geotechnical Pre-Feasibility Study
Sharps Island
Chesapeake Bay, Maryland
E2CR Project No.: 01583-04

Dear Mr. Kotulak:

In accordance with our proposal dated December 26, 2001, and your verbal authorization, we have completed the preliminary feasibility study. Transmitted herewith are five bound copies of our Preliminary Geotechnical Report.

Should you have any questions, or need any additional information, please give us a call.

Very Truly Yours,
E2CR, INC.

Neeraj Singh

Neeraj Singh, P.E.
Project Engineer

Siva Balu, P.E
Chief Executive Officer

Word/2002 Reports/Sharps Island CL

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GEOTECHNICAL PRE-FEASIBILITY STUDY
SHARPS ISLAND
CHESAPEAKE BAY, MARYLAND

EXECUTIVE SUMMARY

This report presents the results of the preliminary geotechnical reconnaissance study conducted for the proposed beneficial use of dredged material project on the north, south and west sides of Sharps Island. Sharps Island in early 1800s covered an area of about 600 acres, and by 1950s it was entirely submerged. Today there is about 8-ft. to 16-ft. of water at the site. Two potential beneficial use areas were evaluated. The layouts of two dike alignments enclose an area between 380 to 2100 acres.

The study focused on the subsurface conditions along the proposed alignments, the suitability of the foundation soils for supporting the dike, the availability of suitable borrow to construct the dike, and developing a preliminary dike section. A total of 27 soil borings were drilled to depths of 30 to 75 feet and laboratory testing was performed to evaluate the index properties, shear strength, and compressibility of selected soil samples. Field investigation was also supported by conducting in-situ vane shear strength tests at 7 locations.

The borings drilled along the proposed dike alignments indicate that there are some soft re-deposited erosion channel areas. The foundation soils in un-eroded geologic areas, except the erosion channel areas, will consists of clayey sand underlain by silty sand which will be suitable for supporting the dike. Some of the borings, however, encountered soft silty clays at the mud line that will need to be undercut and backfilled with sand. For these areas, the depth of required undercut, is anticipated to range from 5+ to 15+ feet with an average of about 10 feet.

The site was found to contain a sufficient quantity of suitable borrow for constructing the perimeter dike to Elevation +20 feet. Suitable borrow was defined as sand with less than 30% fines. It is estimated that the total sand available is about 25 million cubic yards. The net quantity of sand available (assuming a 15% loss of fines during construction) will be about 21 million cubic yards.

A slope stability analysis was performed to develop a preliminary design section for the perimeter dike. For a dike constructed to Elevation + 20 feet in the regular geologic areas, it was determined that the side slopes should have an inclination of 3H: 1V or flatter and that sand borrow containing less than about 30% non-plastic fines should be used.

In the erosion channel areas, the soils are not capable of supporting a dike even to El.+10. The dike alignment should be changed to avoid these areas. If the dike alignment cannot be changed, additional analysis would be required to design a stable dike section. Additional stabilizing measures like wider berms, wick drains, staged construction, etc. would be required for constructing a dike in the areas of previously eroded channels. Additional geotechnical study should be performed in this area, if the alignment is not changed and the dike has to be constructed over deep soft deposits.

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LIST OF TABLES
(Located in Appendix B)

I INTRODUCTION

This report presents the results of the geotechnical pre-feasibility study conducted in association with the conceptual development of a proposed beneficial use of dredged material project at Sharps Island, Talbot County, Maryland. The overall study is being performed by Andrew Miller and Associates, Inc. under contract to the Maryland Environmental Service (MES) and is sponsored by the Maryland Port Administration through MES. This investigation was conducted for Moffatt & Nichol Engineers, Inc., in general accordance with E2CR's proposal dated December 26, 2001, and was authorized by Moffatt & Nichol Engineers.

II SITE LOCATION / DESCRIPTION

Sharps Island is located on the east side of the Chesapeake Bay, in Talbot County, near the County Line between Talbot County and Dorchester County, Maryland as shown on Figure 1, Site Vicinity Map, in Appendix A. It is located about 3.8 miles from Blackwalnut Point and 4.1 miles from Cook Point, as shown on Figure 2, Site Location.

Around the beginning of the 19th century, Sharps Island was a roughly 600-acre farming and fishing community at the mouth of Maryland's Choptank River. At one time it boasted schools, a post office and a popular resort hotel. But between 1850 and 1900, the island lost 80% of its land mass and by 1960 it had been reduced to a shoal. Shoreline changes at Sharps Island are shown on Figure 3. Today it is marked only by a partly submerged lighthouse. The current lighthouse is the third lighthouse at the site and was constructed in 1881-2. During the winter of 1976-7 large ice flows pushed against the tower and tipped it to the south at about a 15 degree angle. The depth of water in the area varies from about 8-feet (ft.) to 16-ft.

III PROJECT DESCRIPTION

It is proposed to construct a beneficial use of dredged material project to restore and create island habitat. The project would be protected by a dike system around Sharps Island. Two Dike Alignments are being evaluated as shown on Figures 4 and 5 in Appendix A. The layout of dike alignment 1 encloses an area of about 380 acres and is outside and east of the oyster bar. Dike alignment No.2, which includes the area enclosed within dike alignment No.1, would enclose a total area of about 2100 acres. If dike alignment No.1 were to be extended to enclose the shoal area (up to boring S-23), the modified dike alignment 1a would enclose an area of 760± acres.

The dike will be constructed by hydraulically or mechanically dredging the sand from the borrow area, stockpiling the sand if necessary, and then hydraulically or mechanically depositing the sand along the dike alignment. Hydraulic placement offers certain construction advantages and was used for analytical purposes in this report. It should be noted that if dike is constructed using only mechanical dredging, the properties of the sand in the dike would change. This could affect the stability of the dike, specially shallow failures. The outside face of the dike will be protected from wave action by armor stone.

The wetlands and uplands within the diked area will be created from sediments dredged from approach channels to Baltimore Harbor. The top of the exterior dike is expected to vary from Elevation (El.) 10 ft. to El. 20 ft. For design purposes, the most severe case was assumed. Hence, the top of the dike was assumed to be at El. +20 ft. for this pre-feasibility study.

IV PURPOSE AND SCOPE

The purpose of this pre-feasibility geotechnical investigation was to:

i) Evaluate the geotechnical conditions at the site, especially along the proposed alignments;

ii) Design a stable dike section at the site in order to establish a preliminary cost estimate (by others) for developing the site;

iii) Evaluate the availability of borrow material (sand) at the site, for the construction of the dike.

It should be understood that this investigation was a preliminary and not a design investigation. The design phases should be conducted at a later date, if this site is selected.

The scope of our study included the following:

- Review the available data such as Maryland Geological Survey (MGS) and Soil Conservation Service (SCS) data.
- Field investigation: drilling 27 test boring and obtaining Shelby tube samples; and conducting in-situ vane shear strength tests at 7 locations.
- Laboratory Testing: conducting laboratory tests to determine the stress history, strength characteristics, index properties of various strata; and suitability of borrow area soils.
- Evaluation: Geotechnical data evaluation, conducting slope stability analysis for the proposed dike system; evaluating the soils at the site (as a borrow) for possible use for constructing the dike.
- Preliminary design and report: Preparation of a geotechnical report, including developing a dike cross-section for use in preparing a cost estimate. The evaluating of off-site borrow areas was outside the scope of this study.

V FIELD INVESTIGATION

The field investigation was conducted in January 2002. A total of 27 borings (S-1 through S-27) were drilled at the approximate locations shown on Figure 5 in Appendix A. The boring coordinates are tabulated in Table 1, in Appendix B. All borings were drilled using a track mounted drill rig placed on a barge. Standard penetration tests were conducted and split spoon samples were obtained in every boring at depth intervals of 2.5-ft. to 5-ft. A representative portion of each sample was placed in a glass jar and was appropriately marked. Seven Shelby tube samples, three-inch in diameter, were obtained in borings S-2, S-4, S-17, S-19 and S-26 in the cohesive soils. All samples were sent to our laboratory for further testing. The depth of the borings varied from about 30-ft. to 75-ft., as tabulated below:

BORING NO.	DEPTH OF WATER (FEET) AT THE TIME OF DRILLING	DEPTH (FEET) OF BORING FROM WATER SURFACE
S-1	9	60
S-2	10	75
S-3	15	60
S-4	16	60
S-5	13	60
S-6	14	60
S-7	15	55.8
S-8	15	32
S-9	13	40
S-10	11	47
S-11	11	50
S-12	12	50
S-13	11	55
S-14	9	44.3
S-15	9	42
S-16	11	60
S-17	11	45
S-18	11	40
S-19	12	43
S-20	12	30

BORING NO.	DEPTH OF WATER (FEET) AT THE TIME OF DRILLING	DEPTH (FEET) OF BORING FROM WATER SURFACE
S-21	11	42.5
S-22	11	52
S-23	8.5	32
S-24	10	55
S-25	11	28.6
S-26	12	38
S-27	9	40

All borings were inspected and the samples were logged and classified by a Geologist. The edited logs of the borings are included in Appendix C.

In-situ vane shear tests were conducted at 7 locations in borings S-2, S-4 and S-26. The vane shear tests were conducted in accordance with ASTM D-2573. The vane shear test basically consists of placing a four-bladed vane in the undisturbed soil and rotating it from the surface to determine the torque required to cause a cylindrical surface to be sheared by the vane. The unit shearing resistance is calculated from the torque force. After establishing the undisturbed shear strength, the sensitivity of the soil was determined by repeating the vane test on the remoulded soil. The interpreted in-situ vane shear data is presented in Table 2 in Appendix B.

VI LABORATORY TESTING

All samples were visually classified in the laboratory by a Geotechnical Engineer to corroborate and/or modify the field classifications. Selected samples were tested for their natural water content, Atterberg limits, sieve analysis, percent fines, shear strength (unconfined compression tests, torvane and pocket penetrometer tests) and consolidation characteristics. A total of 133 water contents, 13 Atterberg limits, 20 sieve analysis, 26 percent fines, 4 consolidation tests and

5 unconfined compression tests were conducted. All tests were conducted in accordance with American Society for Testing Materials (ASTM) procedures. The results of the laboratory tests are included in Appendix D. Summary of laboratory shear strength data is presented in Table 3 in Appendix B. Summary of Consolidation Data is presented in Table 4 in Appendix B. Summary of laboratory and vane shear test results are presented in Table 5 in Appendix B.

VII <u>PUBLISHED DATA</u>

The available data that was reviewed included:

- Maryland Geologic Survey (MGS) Reports and Maps (Figures 6, 7 and 8 in Appendix A)
- Soil Conservation Service Publications for Talbot County, December, 1970.
- MGS's side scan sonar profiles were not conducted for Sharps Island and no data was available from MGS.

A. <u>Area Geology</u>

Sharps Island is entirely under water and the existing geologic maps do not have any information on Sharps Island, as shown on Figure 6. Based on a review of the geology of nearby areas and Poplar Island (Figures 6, 7 and 8), it appears that the site lies in the Coastal Plain Physiographic Province. According to the Geologic Map of Maryland (1986), the surface soils of Sharps Island consists of Lowland Deposits, consisting of Tidal Marsh Deposits (Qtm) and soils of the Kent Island Formation (Qk), see Figure 6 and 7, in Appendix A. The Tidal Marsh Deposits consists of soft silt and clay sediments containing thin beds of sand. The stratum is relatively thin (typically less than 10 feet) and is underlain by the Kent Island Formation. This formation consists of Interbedded layers of sand, silt and clay and ranges from approximately 10 feet to 25 feet in thickness. The soils underlying the Kent Island Formation are known as the Chesapeake Group. The soils of Choptank and Calvert formation Chesapeake group are present to a depth of about 100± feet (see Figure 7). These soils consist of interbedded brown to grayish brown to yellow fine gravelly sand to gray to dark bluish-green argillaceous silt, locally indurated to calcareous sandstones and predominant shell beds. The depth of bedrock is in excess of about 1000± feet. A geologic cross section indicating the various formations near Sharps Island (at Poplar Island) is shown in Figure 7 in Appendix A.

The proposed site was once above sea level. The land has eroded over the years. Therefore, the soils are anticipated to be overconsolidated.

VIII <u>SUBSURFACE CONDITIONS</u>

The borings indicate that at the site there are several subsurface re-deposited erosion channels where the subsurface conditions along the perimeter of the dike and in the potential borrow area (within the diked area) are significantly different. The subsurface conditions in the un-eroded areas and in the erosion channel areas are therefore, discussed separately.

A. <u>Un-Eroded Geologic Areas</u>

The borings indicate that the subsurface stratigraphy in the regular geologic areas generally consist of three major strata, as shown on Figures 9 and 10 – Generalized Subsurface Profile(s) in Appendix A.

Stratum II: This consists of very loose to dense, brown-gray, Clayey Sand with pockets/layers of Silty Sand. The standard penetration resistance (N value) varies from Weight-Of-Rods (WOR) to over 50 blows/ft., and is generally between 2 blows/ft. to 6 blows/ft. Laboratory tests indicate that the natural water content is generally between 14% to 40%. The fines content in the Sand (i.e. percent passing U.S. standard sieve No. 200) varies from 5% and 49% and is generally between 10% and 35%. The sand is semi-angular to angular, and is generally medium to fine. This stratum is fairly consistent through out the site, except in the erosion channel areas. The thickness of this stratum varies from about 6-ft. to about 13-ft.

Stratum IIIa: This consists of loose to dense, gray, brown slightly silty to silty sand with pockets of silty clay. The standard penetration resistance varies from about 6 blows/ft. to over 50 blows/ft. but is generally between 12 blows/ft. and 40 blows/foot. Its thickness varies considerably from zero (in boring S-23 & S-24) to 40+ feet (bottom of the borings) in several borings. The fines content in the Sand (i.e. percent passing U.S. standard sieve No. 200) varies from 10% and 50%. The sand is semi-angular to angular, and is generally medium to fine. This stratum is believed to be the Kent Island Formation.

Stratum IIIb: This stratum consists of grayish brown to greenish gray Clayey Silt/Silty Clay with pockets/layers of gray brown, green gray Silty Sand. It underlies Stratum Ia, Stratum Ib or Stratum II in certain areas of the site. It was mainly encountered in borings S-14, S-17, S-23 and S-24. The N values varies considerably from WOR to 46 blows/ft., but is generally between 5 blows/ft. and 22 blows/ft. The stratum is pre consolidated. Limited laboratory tests indicate that the maximum Preconsolidation pressure (P_c) is about 3.4 ksf. This is interpreted to mean that the island, along the proposed alignment, extended up to about El. +18. The geotechnical properties of the clay portion are as follows.

Liquid limit (LL)	73%
Plasticity Index (PI)	36% to 38%
Water Content	54% to 65%
Sensitivity	2 to 4

Generally, the water content is close to or lower than the liquid limit.

The shear strength of the stratum was evaluated based on the empirical correlation between N and C; vane shear, unconfined compressive strength, and stress history. The shear strength was found to vary considerably. For preliminary design, the cohesion has been assumed to be 800 psf, based primarily on the vane shear, S_u/P_c relationship and unconfined compression test data. It should be noted that Stratum IIIb does contain some pockets of silty sand. This stratum is believed to be part of the Kent Island Formation.

The thickness of silty sand varies from about 5 ft. to 40+ ft. (bottom of the borings), as shown in Table 1 in Appendix B. Some borings encountered auger refusal in gravel layers in the sand. Laboratory tests indicate that the percent fines content in the silty sands (of Stratum Ia and IIIa) vary from 5% to 50%, but is generally less than 30%, as shown in Table 5 in Appendix B. The clayey sands of Stratum II generally have percent fines between 5% and 35%, but some areas have fines in excess of 35%.

B. Erosion Channel Area

Along the perimeter of the dike alignments, the erosion channels were mainly encountered in borings S-2, S-3, S-4, S-11, S-12, S-13, S-23 and S-24. The subsurface conditions in the erosion channel area are highly variable. The subsurface condition generally consists of the following two strata:

Stratum Ia: This stratum consists of very loose to loose brown to grayish brown Silty Sand with layers/pockets of Clayey Sand. The standard penetration resistance (N value) varies from WOR (Weight of rods) to 10 blows/ft., and is generally between WOR to 4 blows/ft. Laboratory tests indicate that the natural water content is generally between 23% to 50%. The fines content in the Sand (i.e. percent passing U.S. standard sieve No. 200) varies from 2% and 48% and is generally between 10% and 35%. The sand is semi-angular to angular, and is generally medium to fine. This stratum is fairly consistent through out the site, except in the erosion channel areas. The thickness of this stratum varies from about 3-ft. to 27-ft.

The stratum is highly discontinuous and is believed to be the redeposited soil in the erosion channels of Stratum II and Stratum III.

Stratum Ib: This stratum consists of brown to grayish brown to gray Clayey Silt/Silty Clay with pockets/layers of gray brown, Silty Sand. It mainly underlies Stratum Ia, but it was also encountered at the surface in borings S-19 and S-26. The Stratum was encountered at a depth of 0-ft. to 27-ft. below the surface and the Stratum is 5-ft. to over 40-ft. thick (bottom of the borings). The N values varies considerably from WOR to 11 blows/ft., but is generally between WOR and 4 blows/ft. The stratum is normally consolidated to slightly pre consolidated. Limited laboratory tests indicate that the maximum Preconsolidation pressure (P_c) is about 0.8 ksf to 1.6 ksf. This is interpreted to mean that the island, along the proposed alignment, extended up to about El. +0 to El.+5. The geotechnical properties of the clay portion are as follows.

Liquid limit (LL)	47% to 82%
Plasticity Index (PI)	22% to 46%
Water Content	26% to 70%
Sensitivity	1 to 3

Generally, the water content is close to or even slightly greater than the liquid limit.

The shear strength of the stratum was evaluated based on the empirical correlation between N and C; vane shear, unconfined compressive strength, and stress history. The shear strength data was found to vary considerably. For preliminary design, the cohesion has been assumed to be 300 psf, based primarily on the vane shear, S_u/P_c relationship and unconfined compression tests. It should be noted that Stratum Ib does contain some pockets of silty sand.

This stratum is highly discontinuous and is believed to be the redeposited soil in the erosion channels of Stratum II and Stratum III.

IX EVALUATION AND ANALYSIS

A. General

The two major issues concerning the geotechnical evaluation of a dredged material placement site are:

- Borrow: Availability of suitable borrow material within the enclosed area:

The borrow should ideally be a sand, with as little fines (i.e. percent passing U.S. Standard sieve No. 200) as possible. If sand is not available locally, it will either have to be imported (which increases the cost significantly), or the dike would have to be constructed from on-site clay (usually not practical due to the low strength of the clay placed in the dike), or another type of enclosed structure would need to be used.

- Foundation: Foundation conditions under the enclosed (perimeter) dike:

Soft clays in the foundation soils would require flatter slopes for the dike, or steeper slopes and stabilizing berms. Stiff clays and sands are the preferred conditions. Flatter slopes or berms would increase the cost. Additionally, areas that have very soft clays may require the total or partial removal (either by displacement or by undercutting) of the very soft clay. The undercut soil has to be disposed of, either on-site or off-site, and the undercut area has to be backfilled with sand.

In evaluating the stability of a slope, four variables have to be considered:

i) The analytical method used.
ii) Shear strength of the foundation soil and the embankment soil.
iii) The slope of the dike.
iv) Factor of safety : acceptable and computed.

B. Borrow: Quality and Quantity of Sand

In evaluating the borrow area, two variable have to be evaluated: i) quality of sand and ii) quantity (volume) of sand.

i) Quality of Sand:

The borings indicate that the sand, in general, is semi angular to angular. The fines content varies from about 5% to 50%, and is generally less than 30%. The sand is Clayey in some areas, and also contains pockets/layers of clay. The sand is considered to be suitable for building the dike. The suitable sand is available in Stratum Ia, Stratum II and in Stratum IIIa. It should be noted that in some areas, such as borings S-7, S-8, S-9, S-10, S-13, S-14, and S-15, the sands are very dense, i.e. in excess of 50 blows/foot. Dredging these very dense sands could be somewhat difficult.

ii) Quantity of Sand

The locations of the potential borrow areas are shown on Figure 11 in Appendix A. The quantity of sand available in all stratums was estimated based on the limited available data. It was assumed that no dredging will be done within 200 feet. of the toe of the dike. The thickness of clay that will need to be stripped and the thickness of sand available at each boring are shown in Table 1 in Appendix B and are also presented on Figure 12 in Appendix A.

The volume of total sand available is estimated to be about 20 million cubic yards. During construction, the bulking will be minimal, since the sand is loose. In addition, about 20% of the fines will be lost. Therefore, the net quantity of sand available for dike construction is estimated to be about 16 million cubic yards.

It appears that adequate sand is available to build the dike to El. 20.

C. Foundation / Slope Stability

i) Analytical Method

Slope stability analyses were conducted using one typical case for the subsurface profile. Purdue University PC STABL-5M program was used to analyze the stability of the slopes. This program incorporates many different analytical methods, such as circular failure and wedge failure. Also, the failures can be analyzed using different approaches, such as the Modified Bishop Method, the Modified Janbu Method and the Spencer Method. For this study, the Modified Bishop method was used. The Janbu Method results in Factor of Safety, which is generally considered to be too conservative, and is about 15% less than the Bishop's Method.

ii) Design Parameters (Shear strength of foundation and embankment)

Along the dike alignments, different foundation conditions were encountered. Two general conditions were analyzed as shown below. Based on in-situ and laboratory test, the following design parameters were used for the foundation soils.

Case IA: Dike to EL.+20, Un-Eroded Geologic Area (Typical Borings S-5 to S-11)

Elevation	Stratum	Type of soil	γ(pcf)	C (psf)	φ(Degree)
El. –15 to El. –30	II	Clayey Sand	110	100	20
Below El. –30	IIIa	Silty Sand	110	0	30

Case IIA: Dike to EL. +20, Erosion Channel Area (Typical boring S-4)

Elevation	Stratum	Type of soil	γ(pcf)	C (psf)	φ(Degree)
El. –15 to El. –25	Ia	Clayey Sand	110	100	20
El. –25 to El. -40	Ib	Silty Clay	110	300	0
Below El. –40	IIIb	Silty Clay	110	600	0

Case IIB: Dike to EL. +10, Erosion Channel Area (Typical boring S-4)

Elevation	Stratum	Type of soil	γ(pcf)	C (psf)	ϕ(degree)
El. -15 to El. -25	Ia	Clayey Sand	110	100	20
El. -25 to El. -40	Ib	Silty Clay	110	300	0
Below El. –40	IIIB	Silty clay	110	600	0

γ = Density of soil in pcf

C = Cohesion in psf

ϕ = Angle of internal friction

The dike will be constructed from the on-site sands. In past projects, the ϕ in the dike has been assumed to be 30° above the water and 28° below the water for hydraulically dredged non-plastic Silty Sands.

All dike sections were analyzed for circular failures (Case I & II). It should be noted that if mechanical dredging is used, the ϕ values used in the above analysis would decrease, thereby reducing the factor of safety especially for shallow failures.

iii) Slope of dike

During construction, the slope of the dike can vary considerably, depending upon the type of soil, placement methodology, and whether the soil is placed above or below the water. Past experience has indicated that dikes constructed from Silty Sands (non-plastic) can achieve slopes as steep as 2H:1V below the water. However, 3H:1V is a more realistically obtainable slope. Also, during dredging, pumping and placement, about 15% of the fines can wash out for hydraulically dredged and placed sand. Thus, if a borrow area has 30% non-plastic fines, the dike will tend to have about 10% to 15% fines. For mechanically dredged and placed sands, the loss of fines would be much smaller. For this pre-feasibility phase, it was assumed that the dike would be constructed by hydraulic dredging, and the slopes achievable would be 3H:1V above and below the water table.

iv) Factor of Safety (FS)

a) Acceptable FS

The acceptable factor of safety was assumed to be 1.3, at the end of the dike construction phase. This was also based on the experience at the Hart-Miller Island Dredged Material Containment Facility and the Poplar Island Environmental Restoration Projects, and was considered to be acceptable to the U.S. Army Corps of Engineers (USACE). The USACE will be involved in the permit process, and will review and approve the final design for this project, if this project is implemented.

b) Computed FS

The exterior dike design sections (regular geologic area) for slope stability analysis are shown on Figure13 (for Exterior dike to El. +20ft) and on Figure 14 (for Exterior dike to El. +20ft and El. +10ft. in erosion channel area) in Appendix A. It should be noted that a 15 ft. wide bench at El. +10 ft was included in analyzing the stability of the dike at El. +20 ft. The results of the analyses are presented in Appendix E. The summary of the analyses is shown on Table 6.

The analysis indicates that the Factor of Safety for the assumed design section is in excess of 1.3 for deep seated and for shallow failures for case I. It is recommended that the slopes of the dike should not exceed as shown on the design section (Figures 13).

For Case II, the Factor of Safety for the dike at El. +20 is less than 1.0 and for dike at El.+10 is about 1.07. Therefore, the design dike section is not stable in the erosion channel and corrective measures will be required. There are three options:

a). Offset the dike alignment to avoid the soft re-deposited erosion channel areas.
b). Undercut to some depth and backfill with clean Sand. Additional analysis would be required to design a stable dike section.
c). Design other corrective measures to stabilize the dike such as, staged construction with stabilizing berm, wick drains, etc.

D. Undercutting

The borings indicate that soft soils consisting of re-deposited soils in the erosion channel were encountered in borings S-2, S-3, S-4, S-11, S-12, S-13, S-23 and S-24. These soft soils should be undercut or the alignment changed. In addition, soft soils should also be anticipated at the surface (mud line) near borings S-10 and S-14. These soft soils (Stratum II) will need to be undercut. As a preliminary estimate, the depth of undercut will vary from about 5+ feet to 15+ feet with an average of about 10 feet. Other areas of soft soils that will need to be undercut should also be anticipated; the limits of these areas will have to be defined during the final study.

X CONCLUSIONS

Based on the limited boring data, the following is concluded:

i) The foundation soils, except in the erosion channel areas, for dike alignments 1 and 2 are anticipated to be mostly loose to dense Clayey Sands (Stratum II) underlain by loose to dense Silty Sands (Stratum IIIa), except near S-14, S-17, S-

23 and S-24, where the clayey sands (Stratum II) are underlain by Silty Clay (Stratum IIIb).

ii) The Silty Sands of Stratum II and IIIa and the Silty Clay of Stratum IIIb are considered to be suitable for supporting the proposed dikes with exterior slope of 3H : 1V and the top of dike at El. + 20.

iii) In the erosion channel areas, the soils of Stratum Ia and Ib are not suitable for supporting the dike and the dike may have to be re-aligned or staged construction with wick drains may have to be used.. However, the Silty Sands of Stratum Ia are suitable for use as borrow.

iv) A total of about 20 million cubic yards of Silty Sand / Clayey Sand and a net (i.e. assuming 20% loss of fines during hydraulic dredging and placement) of about 16+ million cubic yards of Silty Sand / Clayey sand is estimated to be available within the diked area.

REFERENCES

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Terzaghi, K. and Peck, R.B. (1948), *Soil Mechanics in Engineering Practice*, 1st edn., Wiley, New York.

U.S. Navy, Naval Facilities Engineering Command, *Soil Mechanics – Design Manual 7.01*, Alexandria, Virginia, 1986.

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APPENDIX-A

FIGURES

ENGINEERING · CONSULTATION ·

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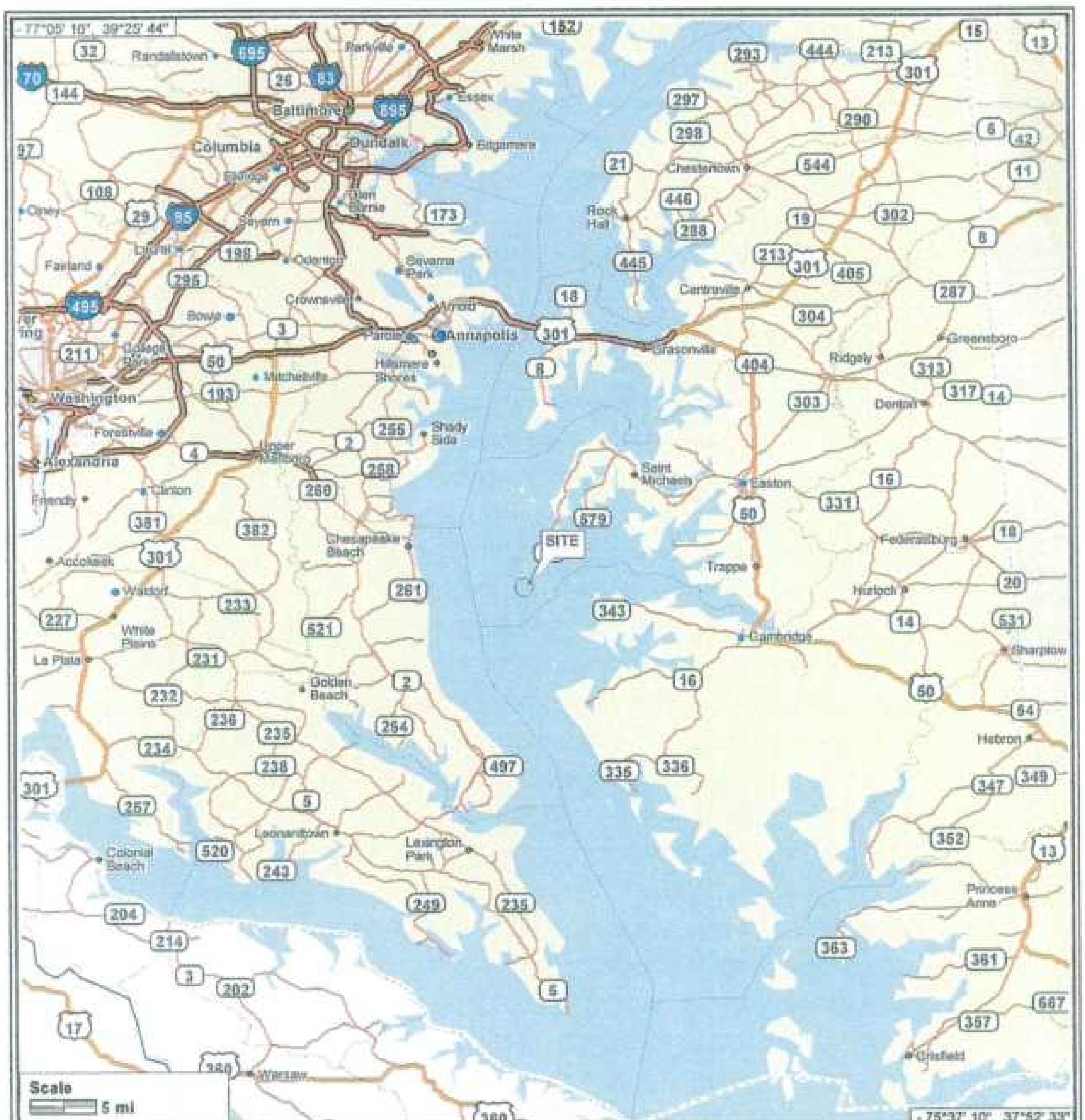
CONSTRUCTION · REMEDIATION ·

SITE VICINITY MAP SHARPS ISLAND TALBOT COUNTY, MD		
FIGURE: 1	DRAWN BY: NS	CHECKED BY:
DATE: JUNE, 02	JOB NO: 01583	

SHARPS ISLAND



Map Image Created Using Precision Mapping Streets 4.0

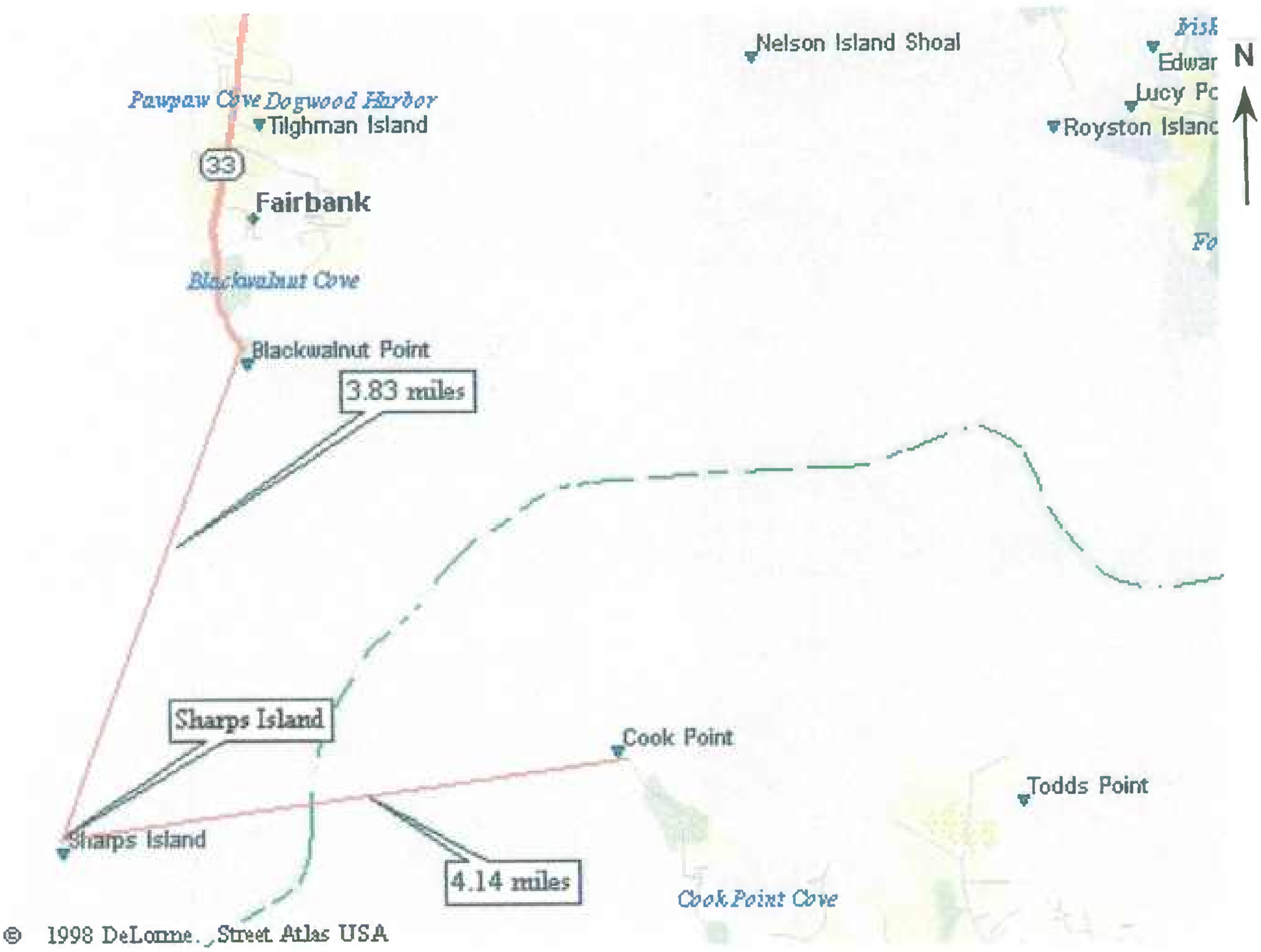
ENGINEERING · CONSULTATION ·

E2CR inc.

CONSTRUCTION · REMEDIATION ·

SITE LOCATION
SHARPS ISLAND
TALBOT COUNTY, MD

FIGURE: 2	DRAWN BY: NS	CHECKED BY:
DATE: JUNE, 02	JOB NO: 01583	

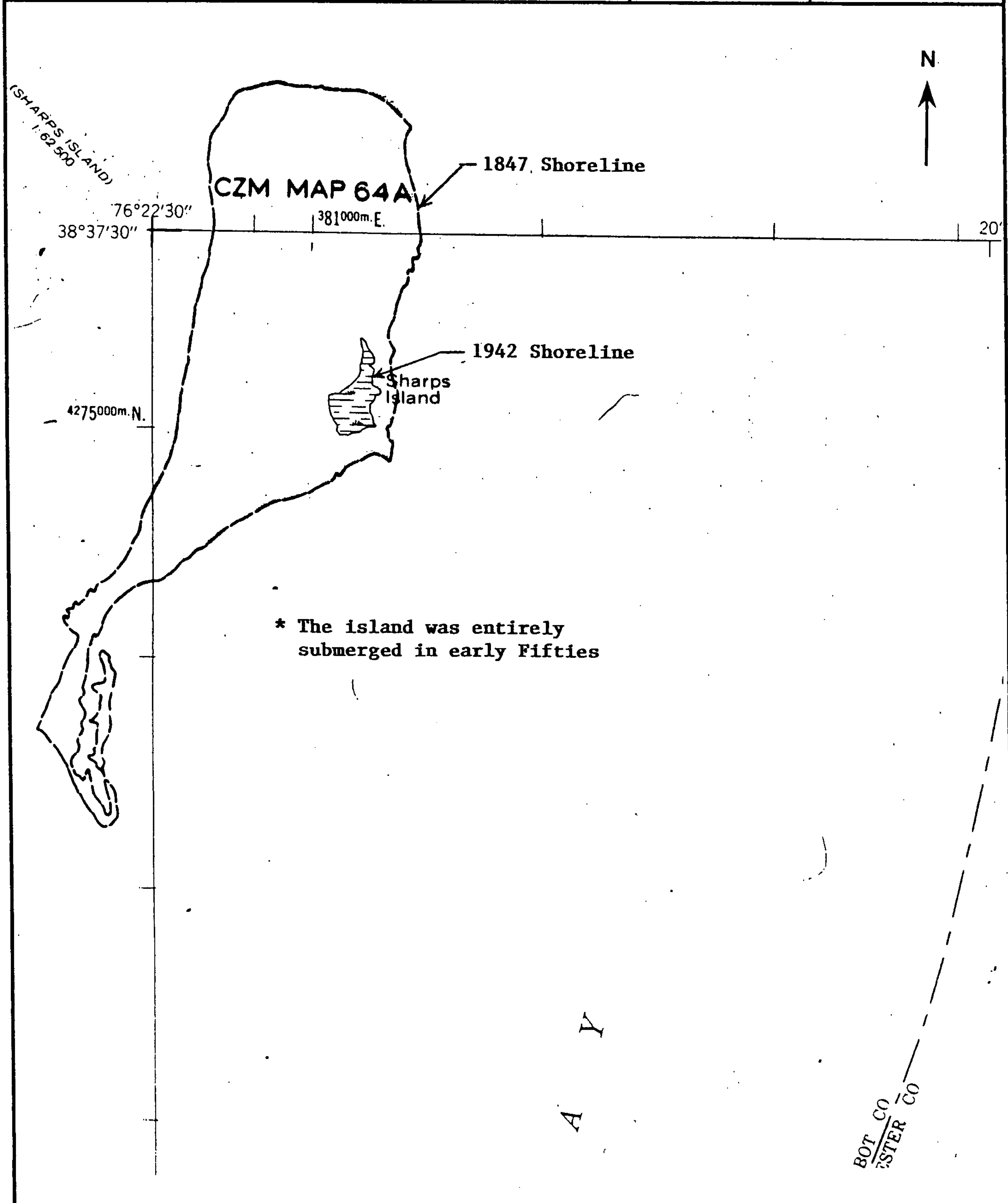


ENGINEERING · CONSULTATION · CONSTRUCTION · REMEDIATION

E2CR inc.

SHORELINE CHANGES
SHARPS ISLAND
TALBOT COUNTY, MD

FIGURE: 3	DRAWN BY: NS	CHECKED BY:
DATE: JUNE, 02	JOB NO: 01583	



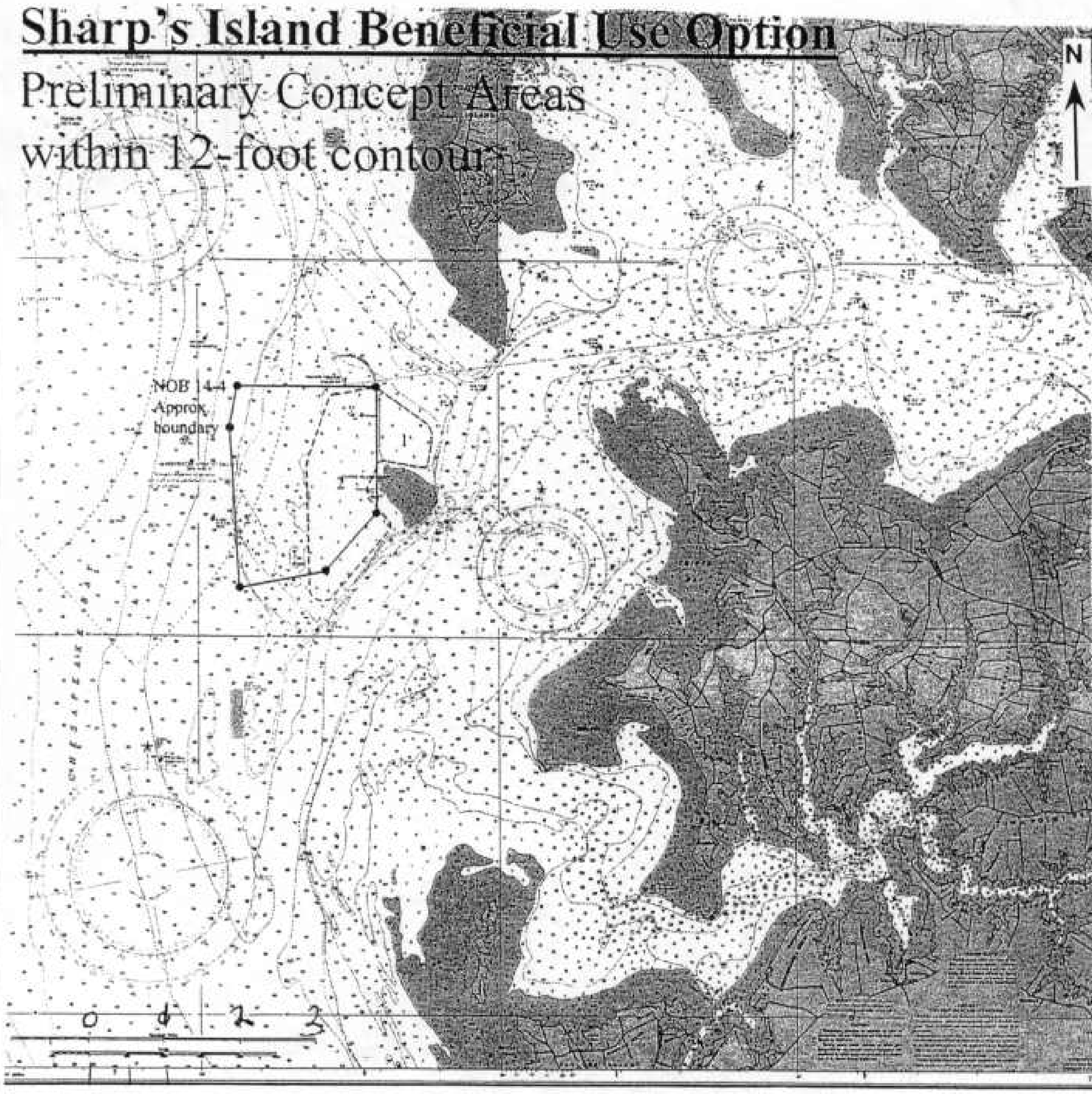
ENGINEERING · CONSULTATION ·

E2CR inc.

CONSTRUCTION · REMEDIATION ·

EXISTING CONDITIONS
SHARPS ISLAND
TALBOT COUNTY, MD

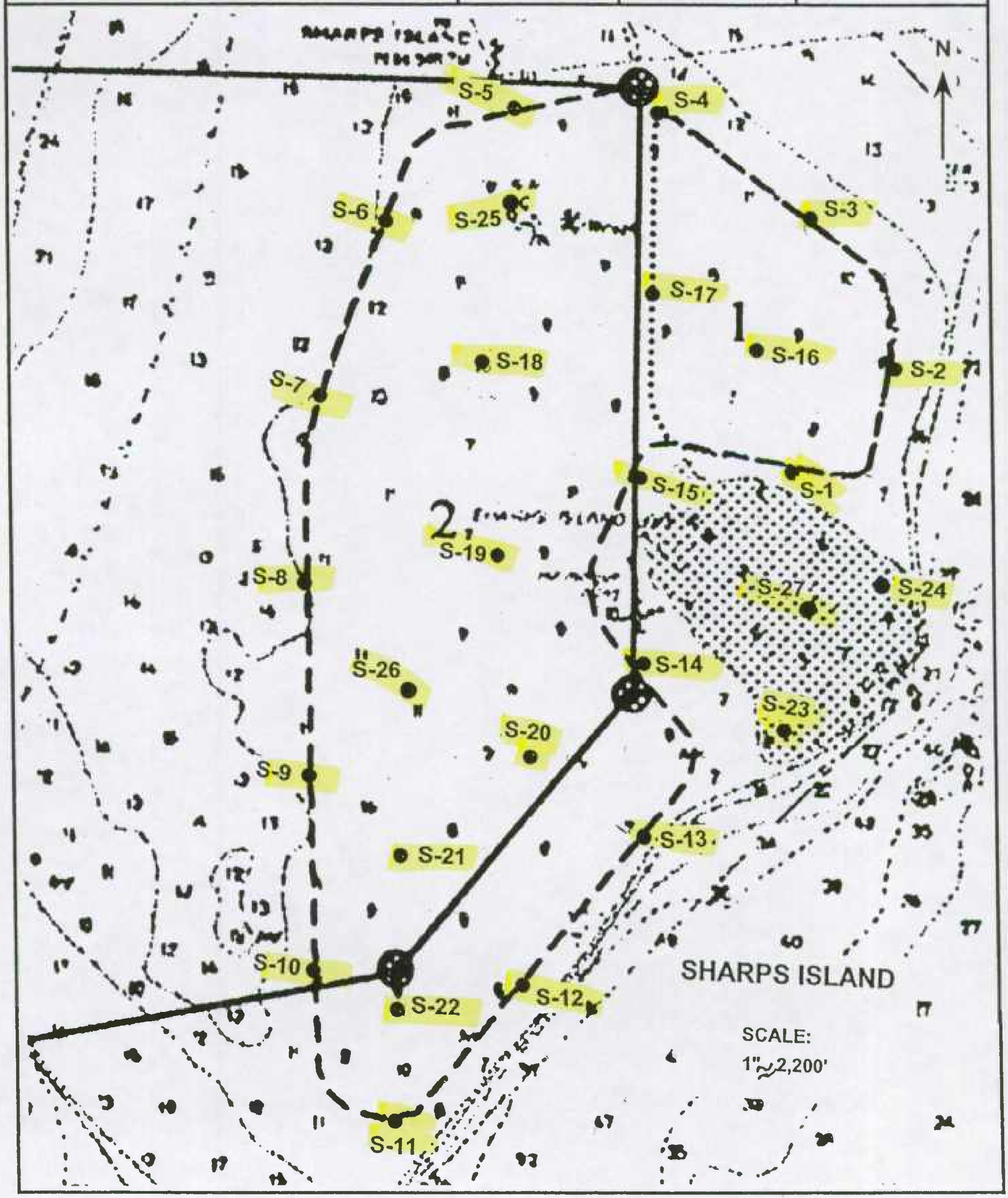
FIGURE: 4	DRAWN BY: NS	CHECKED BY:
DATE: JUNE, 02	JOB NO: 01583	



ENGINEERING · CONSULTATION · E2CR inc. CONSTRUCTION · REMEDIATION ·

ALTERNATE ALIGNMENTS / TEST BORING LOCATION PLAN
SHARPS ISLAND, TALBOT COUNTY, MD

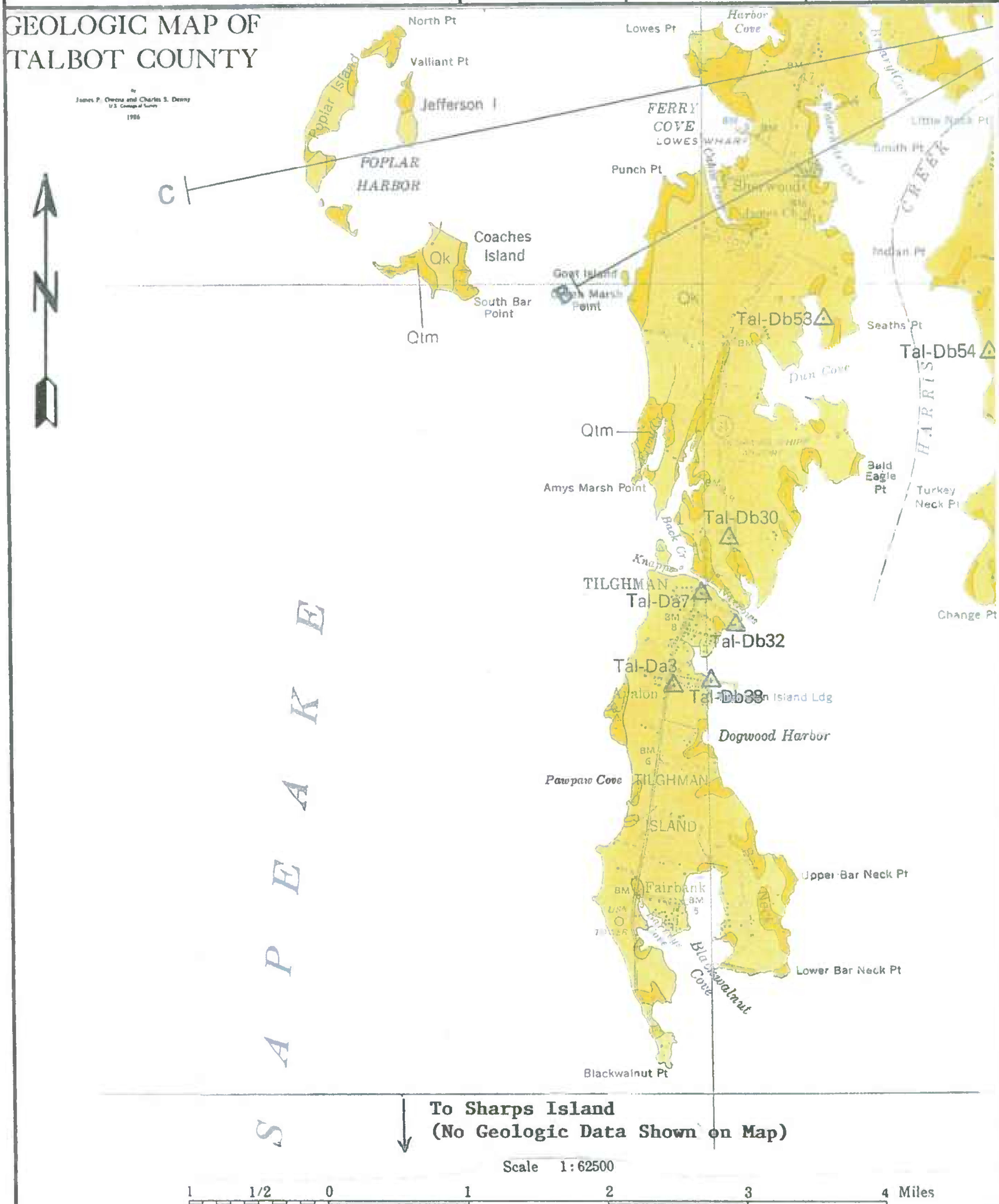
FIGURE: 5	DRAWN BY: NS	CHECKED BY:
DATE: JUNE, 02	JOB NO: 01583	



ENGINEERING · CONSULTATION ·
E2CR inc.
CONSTRUCTION · REMEDIATION ·

GEOLOGICAL MAP NEAR SHARPS ISLAND TALBOT COUNTY, MD

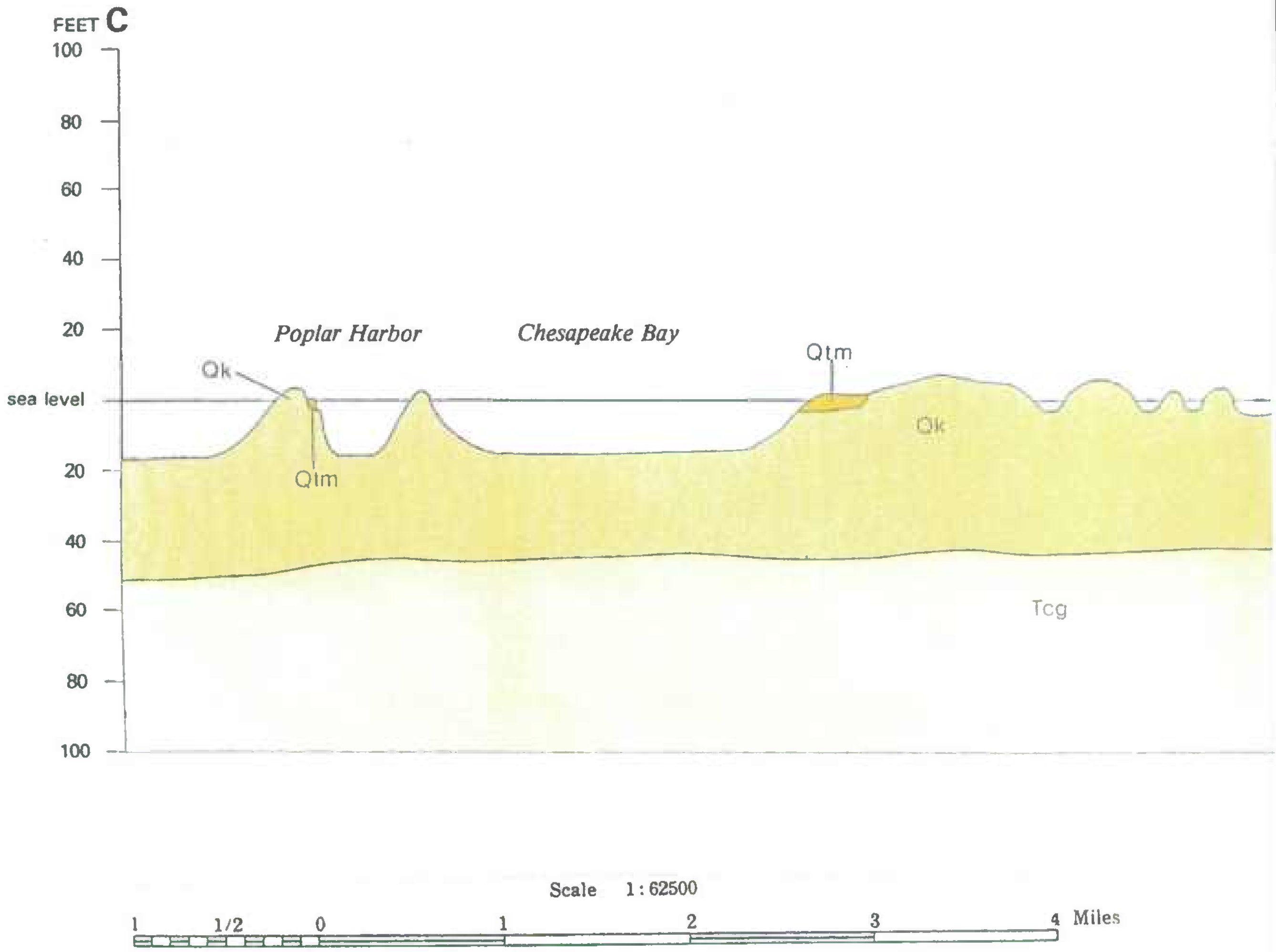
FIGURE: 6	DRAWN BY: NS	CHECKED BY:
DATE: JUNE, 02	JOB NO: 01583	



ENGINEERING · CONSULTATION · E2CR inc. CONSTRUCTION · REMEDIATION ·	GEOLOGICAL CROSS SECTION NEAR SHARPS ISLAND TALBOT COUNTY, MD	
FIGURE: 7	DRAWN BY: NS	CHECKED BY:
DATE: JUNE, 02	JOB NO: 01583	

GEOLOGIC MAP OF TALBOT COUNTY

by
James P. Owens and Charles S. Denny
U.S. Geological Survey
1986



ENGINEERING · CONSULTATION ·

E/2C/R inc.

CONSTRUCTION · REMEDIATION ·

GEOLOGICAL DESCRIPTION OF MAP UNITS
SHARPS ISLAND
TALBOT COUNTY, MD

FIGURE: 8	DRAWN BY: NS	CHECKED BY:
DATE: JUNE, 02	JOB NO: 01583	

DESCRIPTION OF MAP UNITS

Qtm

TIDAL MARSH DEPOSITS (HOLOCENE) — Silt, clay, and sand, particularly near river mouths. Deposits are dark gray-brown due to abundant finely comminuted, decayed organic matter, and are unconsolidated, or "soupy". The largest areas underlain by tidal marsh deposits occur along the Choptank River. The plain underlain by the Kent Island Formation (western half of County) is bordered by many very small areas of tidal marsh deposits. Sediment thickness is not known because these deposits are so poorly exposed. In adjacent areas, thicknesses of about 6 m (20 ft) have been reported (Owens and Denny, 1978, 1979a; Kraft, 1971).

Qk

KENT ISLAND FORMATION (MIDDLE WISCONSIN OR UPPER SANGAMON) — Interstratified silt, sand, and clay; in places, the fine sediment contains abundant organic matter. Silty and sandy sediments underlie most of the western half of the County where they form a nearly featureless plain, deeply indented by many large and small estuaries. Surface altitudes are for the most part less than 6 m (20 ft). The eastern limit of the Kent Island plain is a prominent west-facing escarpment (see Section C-C′). The toe of the scarp is about 7.5 m (25 ft), and the crest ranges from about 15 to 18 m (50-60 ft) in altitude. This presumably estuarine scarp is analogous to the modern Calvert Cliffs on the west side of the Bay. The scarp marks the east shore of an ancestral Chesapeake Bay. The Kent Island plain extends for nearly 200 km (125 mi) along the east side of Chesapeake Bay. The scarp bounding the Kent Island Formation is more prominent in Talbot County than it is to the south.

The Formation ranges from about 3 to 18 m (10-60 ft) in thickness. The base of the unit is at the bottom of a gravel bed overlying dark-gray, clayey silt, or loose white micaceous sand of the lower part of the Chesapeake Group (Owens and Denny, 1979b). Only five holes were augered through the Kent Island Formation. Elsewhere, well logs of Rasmussen and Slaughter (1955), and Mack and others (1971), have been used to determine the thickness of the Formation.

Tcg

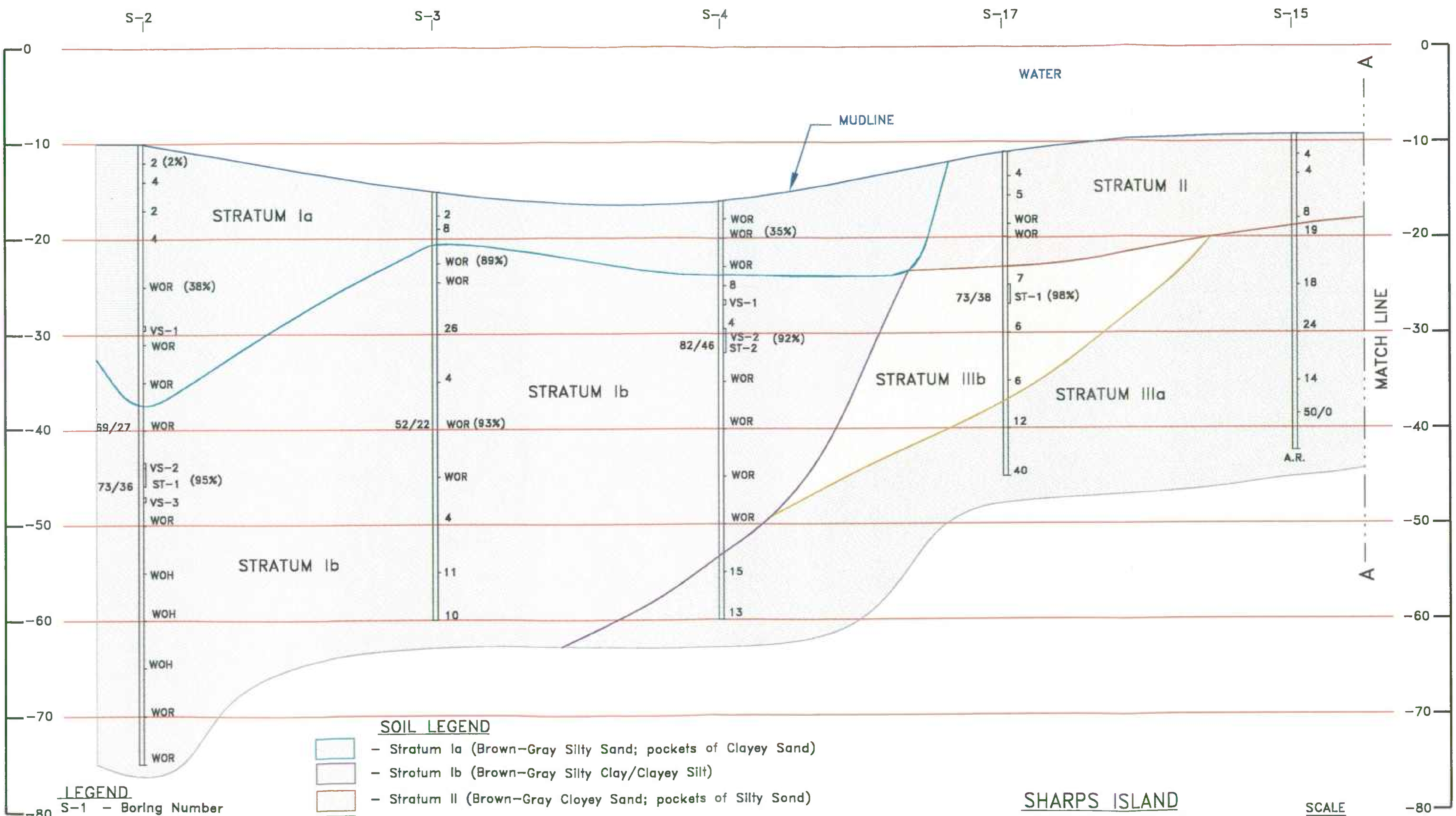
CHESAPEAKE GROUP, UNDIVIDED ((OLDER MIOCENE) — Outcrops along streams in the northern and eastern part of the County. Largely interbedded gray to dark-gray, massive to finely laminated silt and clayey silt and yellow to white, fine-grained, massive, loose, micaceous, slightly feldspathic quartz sand. Most of the thick massive sands, which are extensively burrowed, occur in the northern part of the County near Wye Island, or generally in the updip part of the Formation. Fossils are locally very abundant, typically in thick beds. The type section of the Choptank biostratigraphic zone is in the bluffs along the west side of the Choptank River 4.6 km (2.9 mi) east of Stumptown. Fossils are also present locally in this unit in the Wye River drainage in the northern part of the County where they are of Calvert age (older than Choptank).

The heavy mineral suites in the sand facies are more mature (high zircon content) than those in the finer sediments. In general, the Chesapeake sediments in this County are characterized by zircon, epidote, staurolite, and sillimanite. Hornblende is present but in much smaller concentrations than in the younger Miocene deposits (Pensauken beds).

The clay mineral assemblages in the Chesapeake sediments typically consist of illite and illite/smectite. Kaolinite is present in most samples but generally in lesser amounts than the other two clay species. These clay assemblages are similar to those obtained from age equivalent beds west of Chesapeake Bay (Stefansson and Owens, 1970).

The Chesapeake Group beds in this area are interpreted as open-ocean shelf deposits.

The Chesapeake sediments in Talbot County appear to represent the older part of the Chesapeake Group. The precise age of this part of the group is controversial as it may be Middle or Lower Miocene.



SOIL LEGEND

- Stratum Ia (Brown-Gray Silty Sand; pockets of Clayey Sand)
- Strotum Ib (Brown-Gray Silty Clay/Clayey Silt)
- Stratum II (Brown-Gray Cloyey Sand; pockets of Silty Sond)
- Stratum IIIa (Brown-Gray-Green Silty Sand, pockets of Clay)
- Stratum IIIb (Brown-Gray-Green Silty Clay, pockets of Sond)

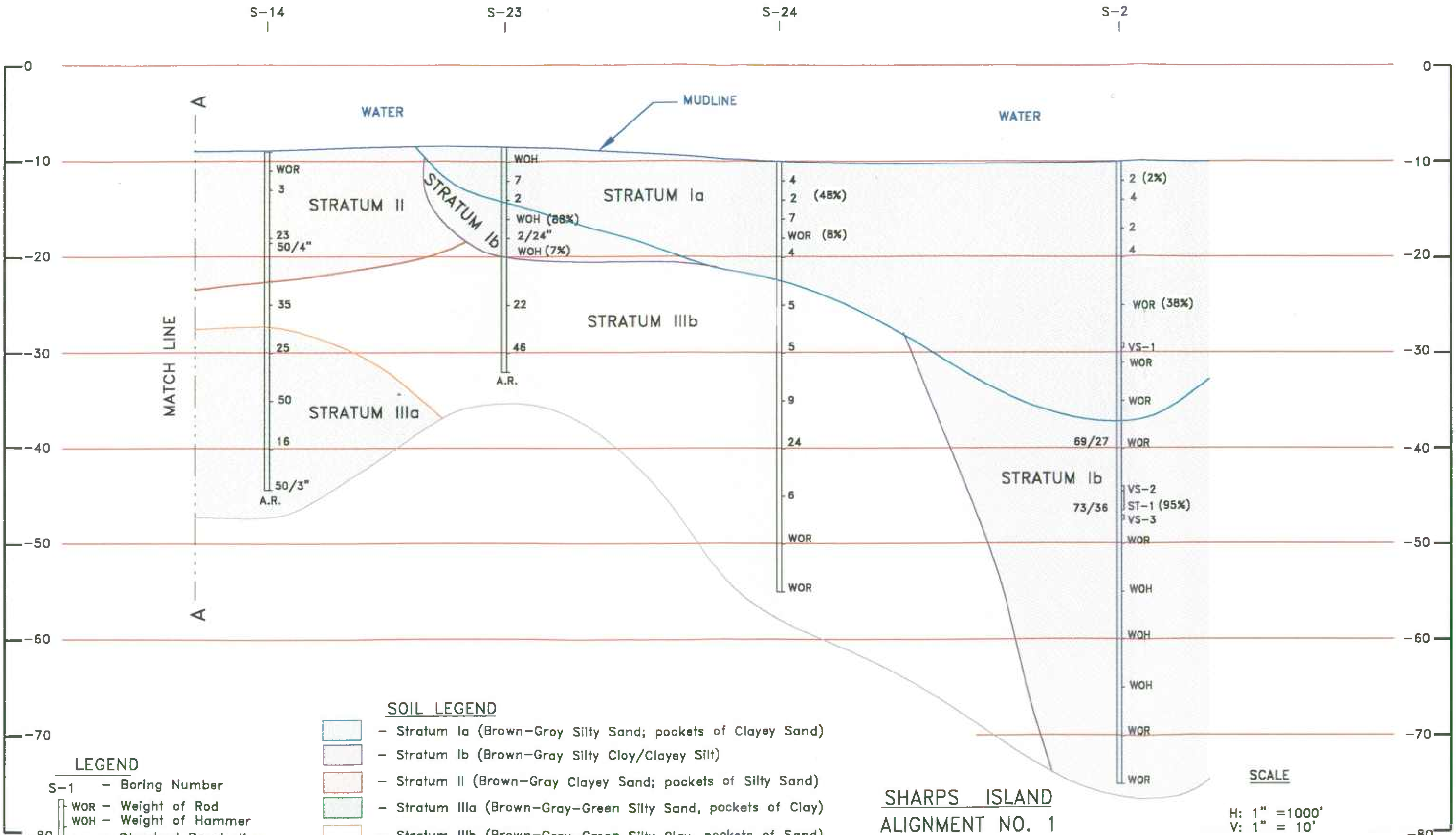
LEGEND

S-1 – Boring Number
WOR – Weight of Rod
WOH – Weight of Hammer
10 – Stondord Penetration Resistonce, Blows/foot
– Water surface elevotion
(22%) – Percentage Fines
66/38 – Liquid Limit/Plasticity Index
ST – Shelby Tube
A.R. – Auger Refusal

SHARPS ISLAND
ALIGNMENT NO. 1

SCALE
H: 1" =1000'
V: 1" = 10'

E2CR, INC.	GENERALIZED SUBSURFACE PROFILE	FIGURE: 9A	DRAWN BY: NS	CHECKED BY:SNG
		DATE: JUNE, 2002	JOB NO.: 01583-04	SCALE:



LEGEND

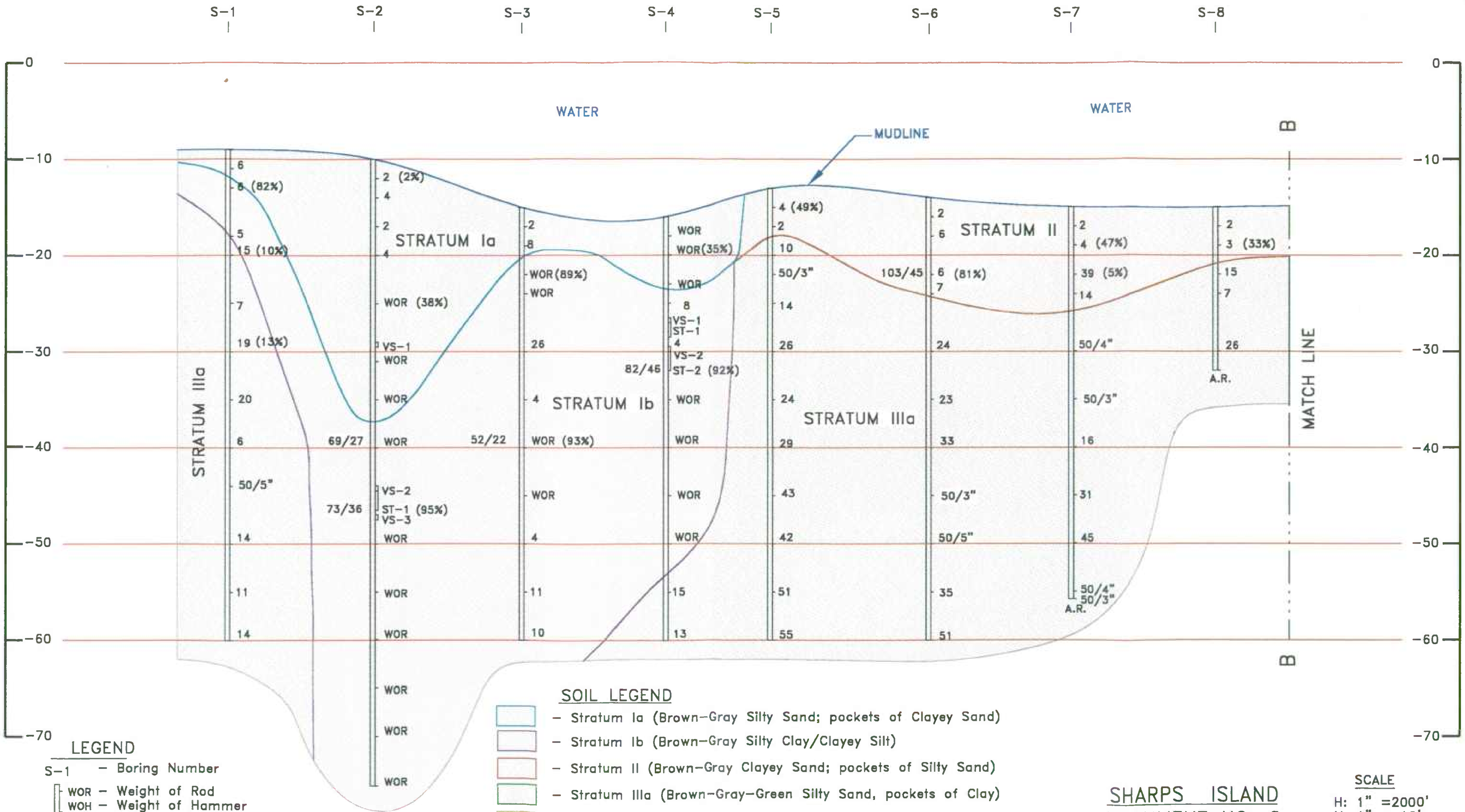
S-1 – Boring Number
WOR – Weight of Rod
WOH – Weight of Hammer
10 – Standard Penetration Resistance, Blows/foot
– Water surface elevation
(22%) – Percentage Fines
66/38 – Liquid Limit/Plasticity Index
ST – Shelby Tube
A.R. – Auger Refusal

SOIL LEGEND

- Stratum Ia (Brown-Groy Silty Sand; pockets of Clayey Sand)
- Stratum Ib (Brown-Gray Silty Cloy/Clayey Silt)
- Stratum II (Brown-Gray Clayey Sand; pockets of Silty Sand)
- Stratum IIIa (Brown-Gray-Green Silty Sand, pockets of Clay)
- Stratum IIIb (Brown-Gray-Green Silty Clay, pockets of Sand)

SHARPS ISLAND
ALIGNMENT NO. 1

E2CR, INC.	GENERALIZED SUBSURFACE PROFILE	FIGURE: 9B	DRAWN BY: NS	CHECKED BY:SNG
		DATE: JUNE, 2002	JOB NO.: 01583-04	SCALE:



LEGEND

- S-1 – Boring Number
- WOR – Weight of Rod
- WOH – Weight of Hammer
- 10 – Standard Penetration Resistance, Blows/foot
- Water surface elevation
- (22%) – Percentage Fines
- 66/38 – Liquid Limit/Plasticity Index
- ST – Shelby Tube
- A.R. – Auger Refusal

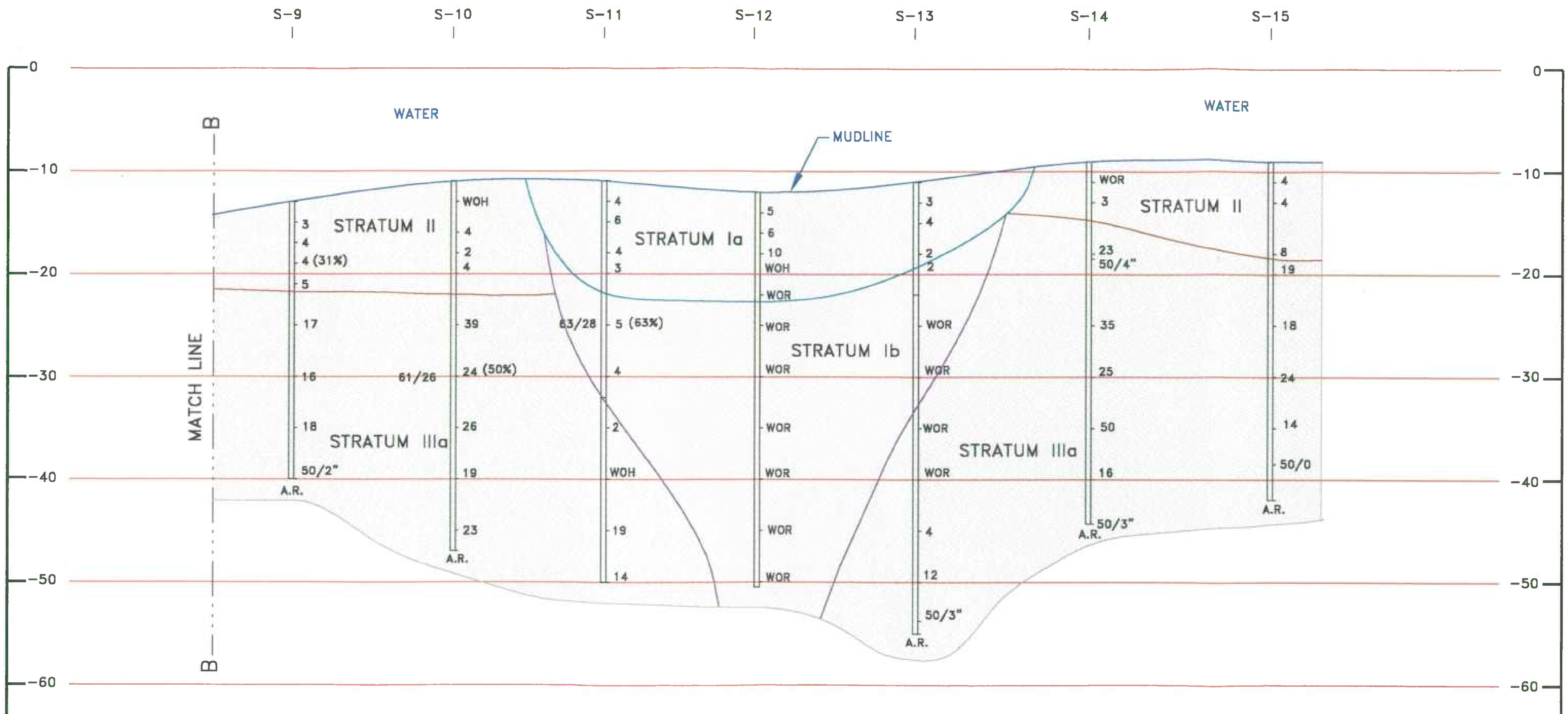
SOIL LEGEND

- Stratum Ia (Brown-Gray Silty Sand; pockets of Clayey Sand)
- Stratum Ib (Brown-Gray Silty Clay/Clayey Silt)
- Stratum II (Brown-Gray Clayey Sand; pockets of Silty Sand)
- Stratum IIIa (Brown-Gray-Green Silty Sand, pockets of Clay)
- Stratum IIIb (Brown-Gray-Green Silty Clay, pockets of Sand)

SHARPS ISLAND
ALIGNMENT NO. 2

SCALE
H: 1" =2000'
V: 1" = 10'

E2CR, INC.	GENERALIZED SUBSURFACE PROFILE	FIGURE: 10A	DRAWN BY: NS	CHECKED BY: SNG
		DATE: JUNE, 2002	JOB NO.: 01583-04	SCALE:



SOIL LEGEND

- Stratum Ia (Brown-Gray Silty Sand; pockets of Clayey Sand)
- Stratum Ib (Brown-Gray Silty Clay/Clayey Silt)
- Stratum II (Brown-Gray Clayey Sand; pockets of Silty Sand)
- Stratum IIIa (Brown-Gray-Green Silty Sand, pockets of Clay)
- Stratum IIIb (Brown-Gray-Green Silty Clay, pockets of Sand)

LEGEND

S-1	–	Boring Number
WOR	–	Weight of Rod
WOH	–	Weight of Hammer
10	–	Standard Penetration Resistance, Blows/foot
	–	Water surface elevation
(22%)	–	Percentage Fines
66/38	–	Liquid Limit/Plasticity Index
ST	–	Shelby Tube
A.R.	–	Auger Refusal

SHARPS ISLAND
ALIGNMENT NO. 2

SCALE
H: 1" =2000'
V: 1" = 10'

E2CR, INC.	GENERALIZED SUBSURFACE PROFILE	FIGURE: 10B	DRAWN BY: NS	CHECKED BY:SB
		DATE: JUNE, 2002	JOB NO.: 01583-04	SCALE:

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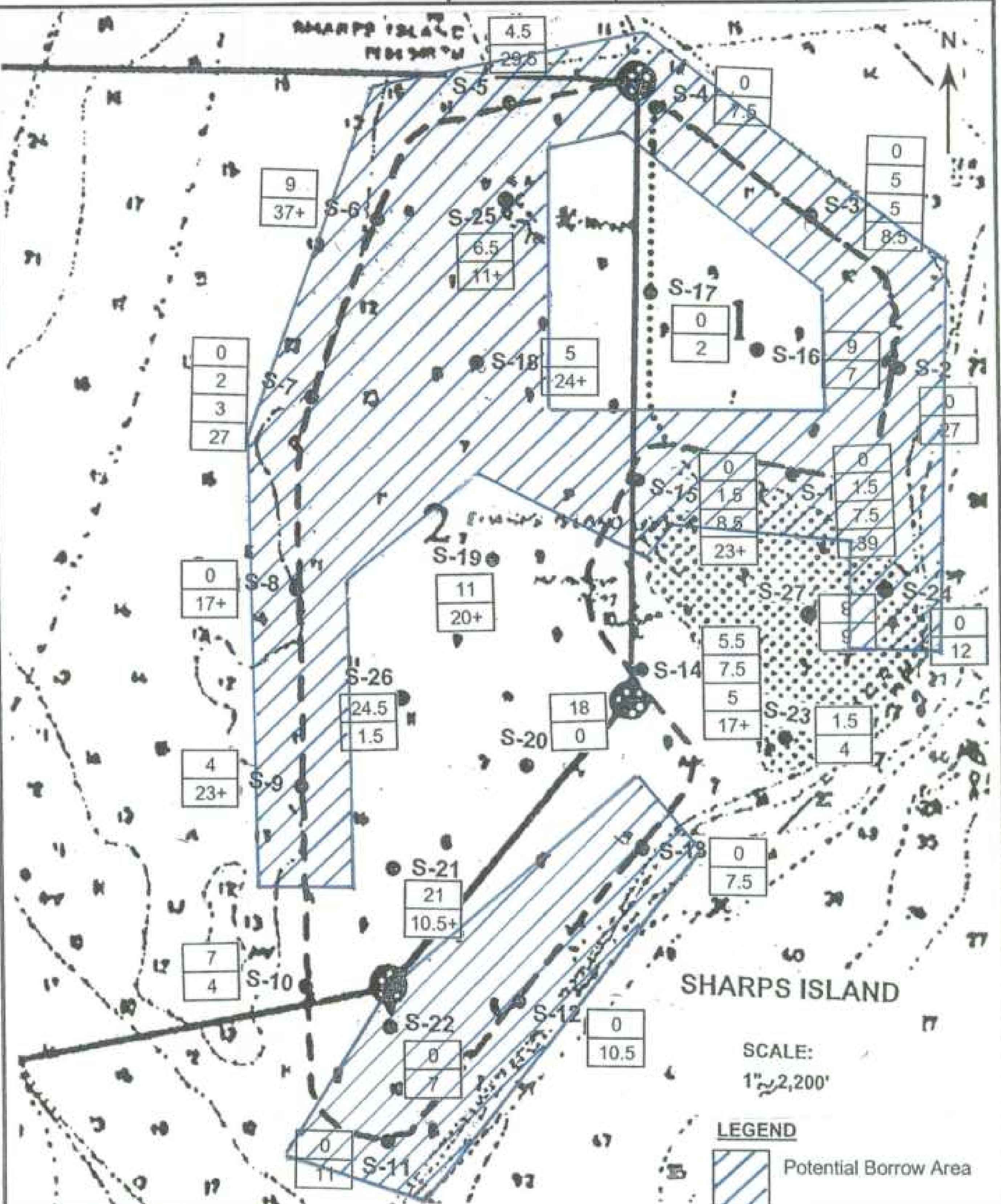
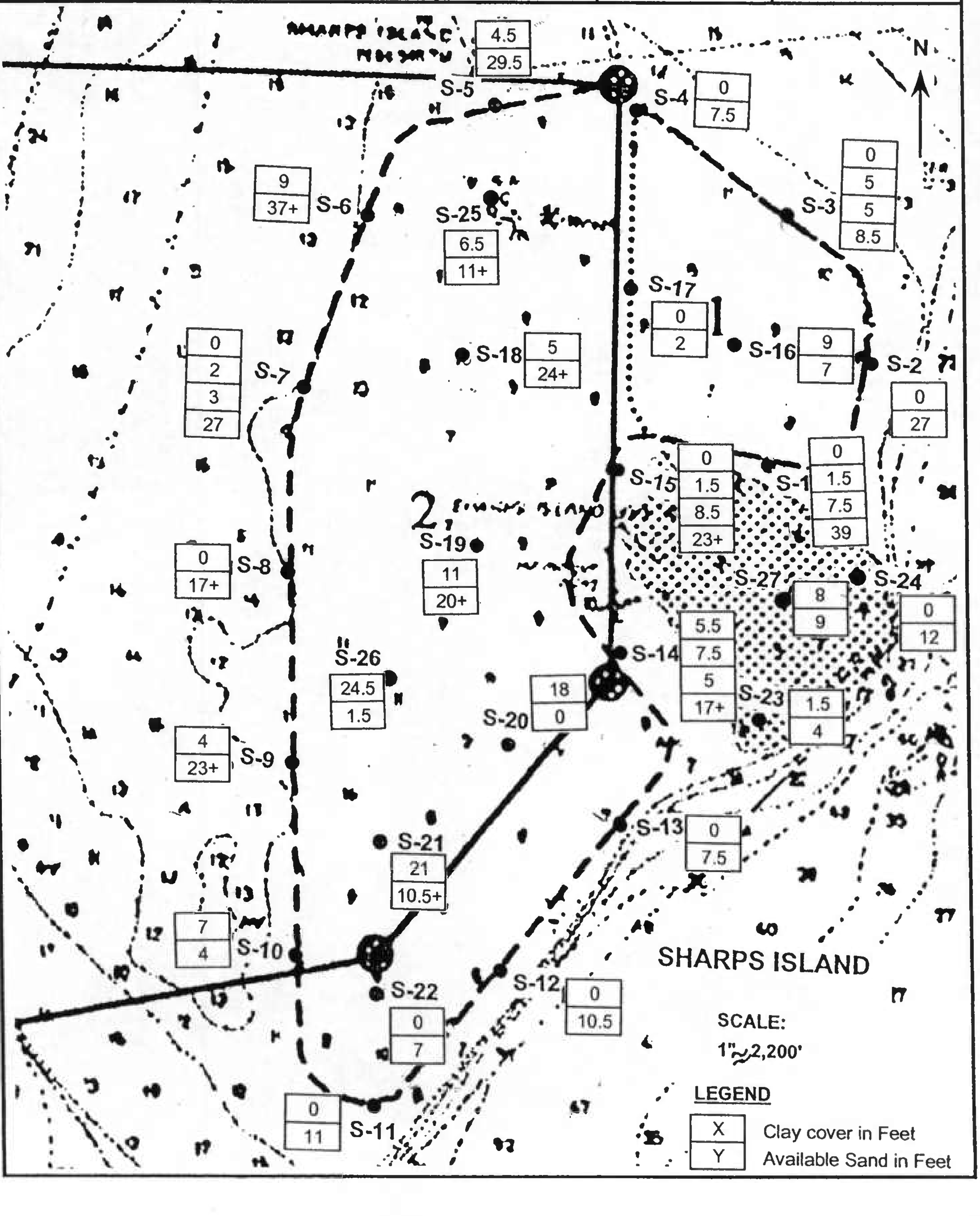
E2CR inc.

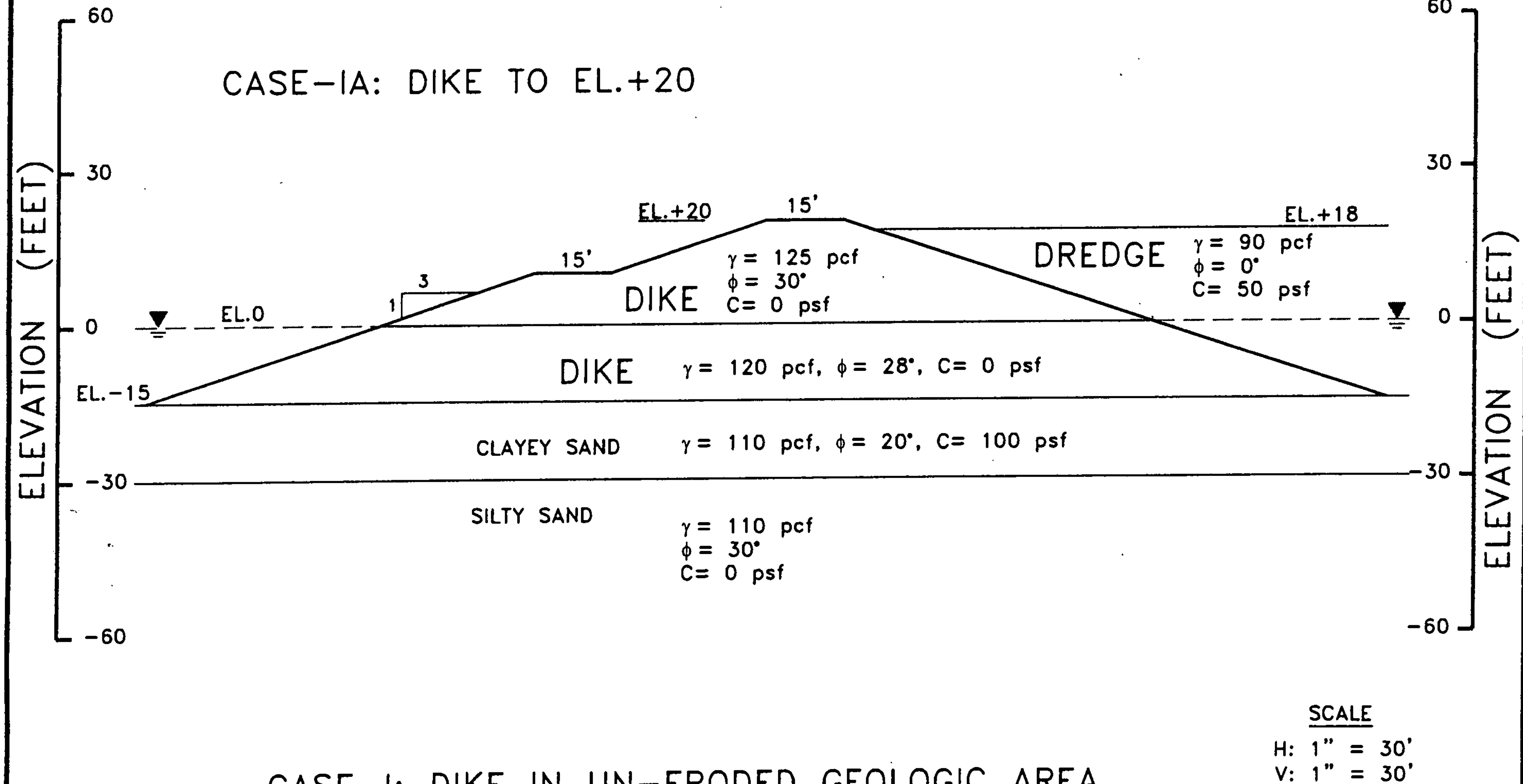
LOCATION OF POTENTIAL BORROW AREA
SHARPS ISLAND
TALBOT COUNTY, MD

FIGURE: 11	DRAWN BY: NS	CHECKED BY:
DATE: JUNE, 02	JOB NO: 01583	



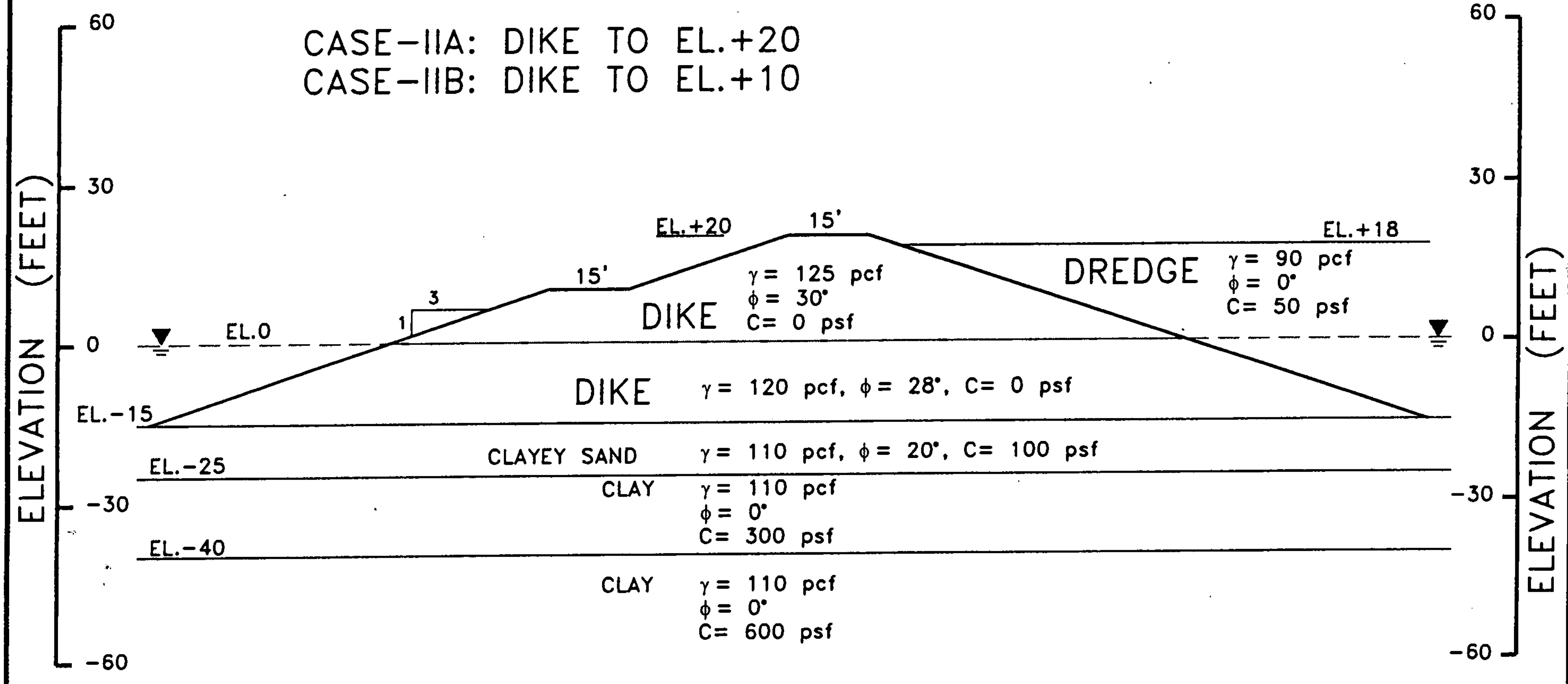
ENGINEERING · CONSULTATION · E2CR inc. CONSTRUCTION · REMEDIATION ·	THICKNESS OF SAND AND CLAY SHARPS ISLAND TALBOT COUNTY, MD		
	FIGURE: 12	DRAWN BY: NS	CHECKED BY:
	DATE: JUNE, 02	JOB NO: 01583	





CASE–I: DIKE IN UN–ERODED GEOLOGIC AREA

E2CR, INC.	SHARPS ISLAND	FIGURE: 13	DRAWN BY: NS	CHECKED BY: SB
	SLOPE STABILITY ANALYSIS	DATE: JUNE, 2002	JOB NO.: 01583	SCALE:



CASE–II: DIKE IN EROSION CHANNEL AREA

SCALE
H: 1" = 30'
V: 1" = 30'

E2CR, INC.	SHARPS ISLAND SLOPE STABILITY ANALYSIS	FIGURE: 14	DRAWN BY: NS	CHECKED BY: SB
		DATE: JUNE, 2002	JOB NO.: 01583	SCALE:

APPENDIX-B

TABLES

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TABLE-1: SUMMARY OF BORING DATA AND BORROW AREA SOILS DATA
SHARPS ISLAND
E2CR PROJECT NO. 01583-04

Boring Number	Coordinates		Total Depth in feet	Water Depth In Feet	Generalized Subsurface (Depths in feet)						Remarks
	Latitude	Longitude			Clay Cover*	Sand	Clay Cover*	Sand	Clay Cover*	Sand	
S-1	38° 37.286'	76° 21.418'	60	9	0	1.5	7.5	39	3		Good
S-2	38° 37.584'	76° 21.086'	75	10	0	27	38				Good
S-3	38° 37.996'	76° 21.391'	60	15	0	5	5	8.5	26.5		Marginal***
S-4	38° 38.280'	76° 21.926'	60	16	0	7.5	33.5	3			Marginal***
S-5	38° 38.271'	76° 22.384'	60	13	4.5	29.5	13				Good
S-6	38° 37.918'	76° 22.906'	60	14	9	37					Good
S-7	38° 37.509'	76° 23.083'	55.8	15	0	2	3	27	8.8		Good
S-8	38° 36.975'	76° 23.161'	32	15	0	17					Good
S-9	38° 36.412'	76° 23.127'	40	13	4	23					Good
S-10	38° 35.887'	76° 23.099'	47	11	7	4	25				Not Good**
S-11	38° 35.440'	76° 22.826'	50	11	0	11	10	18			Good
S-12	38° 35.873'	76° 22.389'	50	12	0	10.5	27.5				Good
S-13	38° 36.275'	76° 21.965'	55	11	0	7.5	23.5	13			Marginal***
S-14	38° 36.753'	76° 21.974'	44.3	9	5.5	7.5	5	17.3			Marginal***
S-15	38° 37.236'	76° 21.988'	42	9	0	1.5	8.5	23			Good

ENGINEERING · CONSULTATION · E2CR inc. CONSTRUCTION · REMEDIATION

TABLE-1: SUMMARY OF BORING DATA AND BORROW AREA SOILS DATA
SHARPS ISLAND
E2CR PROJECT NO. 01583-04

Boring Number	Coordinates		Total Depth in feet	Water Depth in Feet	Generalized Subsurface (Depths in feet)						Remarks
	Latitude	Longitude			Clay Cover*	Sand	Clay Cover*	Sand	Clay Cover*	Sand	
S-16	38° 37.632'	76° 21.552'	60	11	9	7	11	7	15		Marginal***
S-17	38° 37.796'	76° 21.941'	45	11	0	2	25	6.5	0.5		Not Good**
S-18	38° 37.566'	76° 22.527'	40	11	5	24					Good
S-19	38° 37.044'	76° 22.480'	43	12	11	20					Not Good**
S-20	38° 36.459'	76° 22.358'	30	12	18						Not Good**
S-21	38° 36.190'	76° 22.835'	42.5	11	2	3	16	10.5			Not Good**
S-22	38° 35.788'	76° 22.822'	52	11	0	7	1	1	12	20	Marginal***
S-23	38° 36.544'	76° 21.485'	32	8.5	1.5	4	4	2	12		Not Good**
S-24	38° 37.002'	76° 21.109'	55	10	0	12	33				Good
S-25	38° 38.012'	76° 22.429'	28.6	11	6.5	11.1					Good
S-26	38° 36.655'	76° 22.824'	38	12	24.5	1.5					Not Good**
S-27	38° 36.908'	76° 21.360'	40	9	6	8	17				Marginal***

NOTE: The above subsurface conditions are based on visual description and limited laboratory test data. The suitability of the Sand for borrow depends on the percentage fines. Some Silty Sand / Clayey Sand were considered not suitable beacause of higher fines content.

* Includes Clay, Clayey Sand and Sand containing too much fines.

** Not Good : Not economical to mine the Sand when the strip thickness (es) exceeds 10 ft. or when the quantity of Sand is less than 5 ft.

*** Marginal: Clay cover between 5 ft.and 10 ft. or Sand thickness between 5 ft.and 10 ft.

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TABLE-2: SUMMARY OF FIELD VANE SHEAR TEST DATA

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	WATER DEPTH (FEET)	Field Vane Shear Strength		
				Undisturbed (PSF)	Remolded (PSF)	Sensitivity
S-2	VS-1	29-29.5	10	400	200	2
	VS-2	44-44.5		830	300	2.8
	VS-3	47-47.5		800	300	2.7
S-4	VS-1	26.5-27	16	1360	560	2.4
	VS-2	29.5-30		1430	660	2.2
S-26	VS-1	24-24.5	12	860	400	2.2
	VS-2	27-27.5		1300	400	3.3

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TABLE-3: SUMMARY OF LABORATORY SHEAR STRENGTH DATA

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

** From Unconfined Compression Test

BORING NO	SAMPLE NO	DEPTH* (FEET)	SHEAR STRENGTH** (PSF)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS	STRATUM
S-2	ST-1	44.5-46.5	540	57.8	73	36	MH	Ib
S-4	ST-2	30-32	190	66.7	82	46	CH	Ib
S-17	ST-1	25-27	465	53.6	73	38	MH	IIIb
S-19	ST-1	18-20	140	40.0	50	23	CH	Ib
S-26	ST-1	24.5-26.5	90	45.5	47	24	CL	Ib

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TABLE-4: SUMMARY OF CONSOLIDATION TEST DATA

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	DEPTH OF WATER (FEET)	WATER CONTENT (%)	WET DENSITY (PSF)	P_o' (PSF)	P_c' (PSF)	OCR	REMARKS	STRATUM
S-2	ST-1	44.5-46.5	10	67.2	98.7	1300	1600	1.2	Good	Ib
S-4	ST-2	30-32	16	66.8	101.2	590	1600	2.7	Good	Ib
S-17	ST-1	25-27	11	53.6	104.2	630	3400	5.4	Very Good	IIIb
S-19	ST-1	18-20	12	40.0	110.6	340	800	2.4	Marginal	Ib

P_o' = Effective Overburden Pressure
P_c' = Pre Consolidation Pressure
OCR = Over Consolidation Ratio

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TABLE-5: SUMMARY OF LABORATORY AND VANE SHEAR TEST RESULTS

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION GRAVEL (%)	SAND (%)	FINES (%)	UNCONFINED COMPRESSION Cu (PSF)	COHESION PENETRO Cu(PSF)	TORVANE Cu(PSF)	TORVANE (REM) Cu(PSF)	SENSITIVITY	Field Vane Shear Strength UNDISTURBED (PSF)	REMOLDED (PSF)	SENSITIVITY	USCS CLASSIFICATION	STRATUM
S-1	S-1	9.0-11.0	50.4															Ia
	S-2	11.0-13.0	25.7			0	18	82									CL	Ib
	S-3	16.0-18.0	31.7															Ib
	S-4	18.0-20.0	22.7			0	90	10									SP-SM	IIIa
	S-5	23.5-25.0	20.0															IIIa
	S-6	28.5-30	27.5					13									SM	IIIa
	S-7	33.5-35.0																IIIa
	S-8	38.5-40																IIIa
	S-9	43.5-45																IIIa
	S-10	48.5-50																IIIa
	S-11	53.5-55																IIIa
	S-12	58.5-60																IIIa
S-2	S-1	10.0-12.0	30.2			0	98	2									SP	Ia
	S-2	12.0-14.0	26.7															Ia
	S-3	15.0-17.0	32.6															Ia
	S-4	18.0-20.0	25.2															Ia
	S-5	23.5-25	37.5			0	62	38									SM	Ia
	VS-1	29-29.5												400	200	2		Ia
	S-6	29.5-31																Ia
	S-7	33.5-35																Ia
	S-8	38.5-40	70.5	69	27					190	400	300	1.3				MH	Ib
	VS-2	44-44.5												830	300	2.8		Ib
	ST-1	44.5-46.5	67.2	73	36			95	540		1200	540	2.5				MH	Ib
	VS-3	47-47.5												800	300	2.7		Ib
	S-9	48.5-50	60.5							160	300	200	1.5					Ib
	S-10	53.5-55.0	62.0							200	600	300	2.0					Ib
	S-11	58.5-60	67.9							170	340	300	1.1					Ib
	S-12	63.5-65	70.4							140	340	240	1.4					Ib
	S-13	68.5-70	69.0							205	440	260	1.7					Ib

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TABLE-5: SUMMARY OF LABORATORY AND VANE SHEAR TEST RESULTS

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION GRAVEL (%)	SAND (%)	FINES (%)	UNCONFINED COMPRESSION Cu (PSF)	COHESION PENETRO Cu(PSF)	TORVANE Cu(PSF)	TORVANE (REM) Cu(PSF)	SENSITIVITY	Field Vane Shear Strength UNDISTURBED (PSF)	REMOLDED (PSF)	SENSITIVITY	USCS CLASSIFICATION	STRATUM
S-2	S-14	73.5-75	65.7							230	640	340	1.9					Ib
S-3	S-1	15.0-17.0	28.0															Ia
	S-2	17.0-19.0																Ia
	S-3	20.0-22.0	46.2					89		100	200	160	1.3				ML	Ib
	S-4	22.0-24.0	39.8							100								Ib
	S-5	28.5-30.0	20.8															Ib
	S-6	33.5-35								140	400	300	1.3					Ib
	S-7	38.5-40.0	37.0	52	22	0	7	93		1250	900	340	2.6				MH	Ib
	S-8	43.5-45	53.7							650	700	240	2.9					Ib
	S-9	48.5-50	65.1							500	540	340	1.6					Ib
	S-10	53.5-55	64.2							500	600	300	2.0					Ib
	S-11	58.5-60	68.9							625	840	300	2.8					Ib
S-4	S-1	16.0-18.0	35.0							165	240	200	1.2					Ia
	S-2	18.0-20.0	31.5					35		170	300	240	1.3				SC	Ia
	S-3	21.0-23.0	40.4							120	240	200	1.2					Ia
	S-4	23.0-25.0	27.7															Ib
	VS-1	26.5-27.0												1360	560	2.4		Ib
	S-5	28.0-29.5	42.0							650	1000	500	2.0					Ib
	VS-2	29.5-30												1430	660	2.2		Ib
	ST-2	30-32	66.8	82	46			92	190		500	240	2.1				CH	Ib
	S-6	33.5-35	55.7							475	600	340	1.8					Ib
	S-7	38.5-40	55.9							490	800	240	3.3					Ib
	S-8	43.5-45	64.4							375	640	280	2.3					Ib
	S-9	48.5-50.0	65.6							500	1300	440	2.9					Ib
	S-10	53.5-55.0	31.0															IIIa
	S-11	58.5-60.0	24.6															IIIa
S-5	S-1	13.0-15.0	39.8					49									SC	II
	S-2	15.0-17.0	27.3															II
	S-3	18.0-20.0	26.7															IIIa
	S-4	20.0-22.0	21.3															IIIa
	S-5	23.5-25.0	25.1															IIIa

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TABLE-5: SUMMARY OF LABORATORY AND VANE SHEAR TEST RESULTS

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			UNCONFINED COMPRESSION Cu (PSF)	COHESION				Field Vane Shear Strength			USCS CLASSIFICATION	STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO Cu(PSF)	TORVANE Cu(PSF)	TORVANE (REM) Cu(PSF)	SENSITIVITY	UNDISTURBED (PSF)	REMOLDED (PSF)	SENSITIVITY		
S-5	S-6	28.5-30.0																IIIa
	S-7	33.5-35.0																IIIa
	S-8	38.5-40.0								1500	1240							IIIa
	S-9	43.5-45.0																IIIa
	S-10	48.5-50.0																IIIa
	S-11	53.5-55.0																IIIa
	S-12	58.5-60.0																IIIa
S-6	S-1	14-16																II
	S-2	16-18	24.0															II
	S-3	20-22	59.5	103	45	0	19	81									MH	II
	S-4	22-24	34.3							650	700	360	1.9					II
	S-5	28.5-30	28.7															IIIa
	S-6	33.5-35																IIIa
	S-7	38.5-40																IIIa
	S-8	43.5-45																IIIa
	S-9	48.5-50																IIIa
	S-10	53.5-55																IIIa
	S-11	58.5-60																IIIa
S-7	S-1	15.0-17.0	22.0															II
	S-2	17.0-19.0	33.3					47									SC	II
	S-3	20.0-22.0	15.1			16	79	5									SP-SM	II
	S-4	22-24	13.8															II
	S-5	28.5-30																IIIa
	S-6	33.5-35																IIIa
	S-7	38.5-40																IIIa
	S-8	43.5-45																IIIa
	S-9	48.5-50																IIIa

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TABLE-5: SUMMARY OF LABORATORY AND VANE SHEAR TEST RESULTS

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			UNCONFINED COMPRESSION Cu (PSF)	COHESION				Field Vane Shear Strength			USCS CLASSIFICATION	STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO Cu(PSF)	TORVANE Cu(PSF)	TORVANE (REM) Cu(PSF)	SENSITIVITY	UNDISTURBED (PSF)	REMOLDED (PSF)	SENSITIVITY		
S-7	S-10	53.5-55																IIIa
	S-11	55.5-55.8																IIIa
S-8	S-1	15.0-17.0	24.5															II
	S-2	17.0-19.0	24.4					33									SC	II
	S-3	20.0-21.0	28.2															IIIa
	S-4	22-24	25.2															IIIa
	S-5	28.5-30																IIIa
S-9	S-1	13-15	25.1															II
	S-2	15-17	23.6															II
	S-3	17-19	37.9					31									SC	II
	S-4	19-21	37.7															II
	S-5	23.5-25															SM	IIIa
	S-6	28.5-30																IIIa
	S-7	33.5-35																IIIa
	S-8	38.5-40																IIIa
S-10	S-1	11-13	25.9															II
	S-2	14-16	31.5															II
	S-3	16-18	31.9															II
	S-4	18-20	23.3															II
	S-5	23.5-25																IIIa
	S-6	28.5-30	42.8	61	26	0	50	50									SM	IIIa
	S-7	33.5-35																IIIa
	S-8	38.5-40																IIIa
	S-9	43.5-45																IIIa
S-11	S-1	11-13	33.3															Ia
	S-2	13-15	35.0															Ia

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TABLE-5: SUMMARY OF LABORATORY AND VANE SHEAR TEST RESULTS

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			UNCONFINED COMPRESSION Cu (PSF)	COHESION				Field Vane Shear Strength			USCS CLASSIFICATION	STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO Cu(PSF)	TORVANE Cu(PSF)	TORVANE (REM) Cu(PSF)	SENSITIVITY	UNDISTURBED (PSF)	REMOLDED (PSF)	SENSITIVITY		
S-11	S-3	16-18	23.2															Ia
	S-4	18-20	25.5															Ia
	S-5	23.5-25	49.2	63	28	0	37	63		625	940	640	1.5				MH	Ib
	S-6	28.5-30																Ib
	S-7	33.5-35																Ib
	S-8	38.5-40																IIIa
	S-9	43.5-45																IIIa
	S-10	48.5-50																IIIa
S-12	S-1	12-14	34.9															Ia
	S-2	14-16	32.3															Ia
	S-3	16-18	28.1															Ia
	S-4	18-20																Ia
	S-5	20-22	33.3															Ia
	S-6	23.5-25	38.5							115	300	200	1.5					Ib
	S-7	28.5-30	34.6	NP	NP			84		130	240	240	1.0				ML	Ib
	S-8	33.5-35	35.6							120	300	200	1.5					Ib
	S-9	38.5-40	38.8							145	300	200	1.5					Ib
	S-10	43.5-45	58.3	58	27			88		205	500	340	1.5				MH	Ib
	S-11	48.5-50	56.4							205	500	360	1.4					Ib
S-13	S-1	11-13	34.3															Ia
	S-2	13-15	29.0															Ia
	S-3	16-18	30.8															Ia
	S-4	18-20																Ib
	S-5	20-22								100								Ib
	S-6	23.5-25								175	340	200	1.7					Ib
	S-7	28.5-30																IIIa
	S-8	33.5-35																IIIa
	S-9	38.5-40																IIIa
	S-10	48.5-50																IIIa
	S-11	53.5-53.8																IIIa

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TABLE-5: SUMMARY OF LABORATORY AND VANE SHEAR TEST RESULTS

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			UNCONFINED COMPRESSION Cu (PSF)	COHESION				Field Vane Shear Strength			USCS CLASSIFICATION	STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO Cu(PSF)	TORVANE Cu(PSF)	TORVANE (REM) Cu(PSF)	SENSITIVITY	UNDISTURBED (PSF)	REMOLDED (PSF)	SENSITIVITY		
S-14	S- 1	9-11	27.3															II
	S- 2	11-13	32.5															II
	S- 3	16-18	10.9															IIIa
	S- 4	18-18.4																IIIa
	S- 5	23.5-25																IIIa
	S- 6	28.5-30																IIIa
	S- 7	33.5-35																IIIa
	S- 8	38.5-40																IIIa
	S- 9	43.5-44.3																IIIa
S-15	S-1	9-11	28.9															II
	S-2	11-13	33.8															II
	S-3	16-18	29.9															II
	S-4	18-20																IIIa
	S-5	23.5-25																IIIa
	S-6	28.5-30																IIIa
	S-7	33.5-35																IIIa
	S-8	38.5-50																IIIa
S-16	S-1	11-13	30.0					42									SC	II
	S-2	13-15	27.8			12	50	38									SC	II
	S-3	16-18																II
	S-4	18-20																II
	S-5	23.5-25																IIIa
	S-6	28.5-30.0	56.3	73	36	0	8	92		1200	1100	360	3.0				MH	IIIb
	S-7	33.5-35.0								750	960	240	4.0					IIIb
	S-8	38.5-40																IIIa
	S-9	43.5-45																IIIa
	S-10	48.5-50																IIIb
	S-11	53.5-55																IIIb
	S-12	58.5-60																IIIb

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TABLE-5: SUMMARY OF LABORATORY AND VANE SHEAR TEST RESULTS

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			UNCONFINED COMPRESSION Cu (PSF)	COHESION				Field Vane Shear Strength			USCS CLASSIFICATION	STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO Cu(PSF)	TORVANE Cu(PSF)	TORVANE (REM) Cu(PSF)	SENSITIVITY	UNDISTURBED (PSF)	REMOLDED (PSF)	SENSITIVITY		
S-17	S-1	11-13	27.4															II
	S-2	13-15	26.2															II
	S-3	16-18	28.7															II
	S-4	18-20	29.6															II
	S-5	23.5-25	64.5															IIIb
	ST-1	25-27	53.6	73	38	0	2	98	465	1000	900	440	2.0				MH	IIIb
	S-6	28.5-30																IIIb
	S-7	33.5-35								750	700	200	3.5					IIIb
	S-8	38.5-40																IIIa
	S-9	43.5-45																IIIa
S-18	S-1	11-13																Ib
	S-2	13-15	43.9					72		500	400	200	2.0				CL	Ib
	S-3	16-18	32.4			0	68	32		140	200	140	1.4				SC	II
	S-4	18-20	31.1					31									SC	II
	S-5	23.5-25	23.0			18	71	11									SM	IIIa
	S-6	28.5-30																IIIa
	S-7	33.5-35																IIIa
	S-8	38.5-40																IIIa
S-19	S-1	12-14								210	440	360	1.2					Ib
	S-2	14-16	39.5					76		130	400	300	1.3				CL	Ib
	S-3	16-18	33.1							110	300	300	1.0					Ib
	ST-1	18-20	40.0	50	23			68	140		140	120	1.2				CH	Ib
	S-4	20-22	44.4					58		800	740	400	1.9				CL	Ib
	S-5	23.5-25																IIIa
	S-6	28.5-30	27.1			0	87	13									SC-SM	IIIa
	S-7	33.5-35	23.8			4	77	19									SM	IIIa
	S-8	38.5-40																IIIa
S-20	S-1	12-14																II
	S-2	14-16	18.4															II
	S-3	17-19	49.1							3250	1640	600	2.7					IIIb
	S-4	19-21								3500	1500	700	2.1					IIIb

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TABLE-5: SUMMARY OF LABORATORY AND VANE SHEAR TEST RESULTS

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			UNCONFINED COMPRESSION Cu (PSF)	COHESION				Field Vane Shear Strength			USCS CLASSIFICATION	STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO Cu(PSF)	TORVANE Cu(PSF)	TORVANE (REM) Cu(PSF)	SENSITIVITY	UNDISTURBED (PSF)	REMOLDED (PSF)	SENSITIVITY		
S-20	S-5	23.5-25								3750	2100	1100	1.9					IIIb
	S-6	28.5-30								2000	1700	740	2.3					IIIb
S-21	S-1	11-13																II
	S-2	13-15	29.8															II
	S-3	16-18	26.3															II
	S-4	18-20																II
	S-5	23.5-25								130	300	200	1.5					IIIb
	S-6	28.5-30								190	450	240	1.9					IIIb
	S-7	33.5-35																IIIa
	S-8	38.5-40																IIIa
S-22	S-1	11-13	26.7															II
	S-2	13-15	29.6															II
	S-3	15-17	24.7															II
	S-4	17-19								1500	1360	560	2.4					IIIb
	S-5	19-21								1250	1100	440	2.5					IIIb
	S-6	23.5-25								3250	1400	700	2.0					IIIb
	S-7	28.5-30								1625	900	700	1.3					IIIb
	S-8	33.5-35																IIIa
	S-9	38.5-40																IIIa
	S-10	43.5-45																IIIa
	S-11	48.5-50																IIIa
S-23	S-1	8.5-10																Ia
	S-2	10-12																Ia
	S-3	12-14	30.6															Ia
	S-4	14-16	33.7					88									CL	Ib
	S-5	16-18																Ib
	S-6	18-20	29.3			1	92	7									SP-SM	IIIa
	S-7	23.5-25								2125	1600	800	2.0					IIIb
	S-8	28.5-30								3625	1700	800	2.1					IIIb

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TABLE-5: SUMMARY OF LABORATORY AND VANE SHEAR TEST RESULTS

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			UNCONFINED COMPRESSION Cu (PSF)	COHESION				Field Vane Shear Strength			USCS CLASSIFICATION	STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO Cu(PSF)	TORVANE Cu(PSF)	TORVANE (REM) Cu(PSF)	SENSITIVITY	UNDISTURBED (PSF)	REMOLDED (PSF)	SENSITIVITY		
S-24	S-1	10-12	31.1															Ia
	S-2	12-14	32.3					48									SM	Ia
	S-3	14-16																Ia
	S-4	16-18	30.6					8									SP-SM	Ia
	S-5	18-20																Ia
	S-6	23.5-25																Ia
	S-7	28.5-30								750	840	600	1.4					IIIb
	S-8	33.5-35								1000	860	560	1.5					IIIb
	S-9	38.5-40								500	540	340	1.6					IIIb
	S-10	43.5-45								700	740	340	2.2					IIIb
	S-11	48.5-50								750	740	300	2.5					IIIb
	S-12	53.5-55								700	760	300	2.5					IIIb
S-25	S-1	11-13	32.2					84		300	640	400	1.6				CL	Ib
	S-2	13-15	48.3			0	14	86		500	740	500	1.5				CL	Ib
	S-3	16-18																II
	S-4	18-20																IIIa
	S-5	23.5-25	23.7					10									SM	IIIa
	S-6	27-28.6																IIIa
S-26	S-1	12-14	30.9					83		250	560	240	2.3				CL	Ib
	S-2	14-16	25.5							220	400	200	2.0					Ib
	S-3	17-19	40.2					55		140	260	200	1.3				CL	Ib
	S-4	19-21																Ib
	VS1	24-24.5												860	400	2.2		Ib
	ST1	24.5-26.5	45.5	47	24	0	17	83	90		220	160	1.4				CL	Ib
	VS2	27-27.5												1300	400	3.2		IIIb
	S-5	28.5-30								375	440	260	1.7					IIIb
	S-6	33.5-35																IIIb
	S-7	38-38.5																IIIa

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TABLE-5: SUMMARY OF LABORATORY AND VANE SHEAR TEST RESULTS

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT(%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			UNCONFINED COMPRESSION Cu (PSF)	COHESION				Field Vane Shear Strength			USCS CLASSIFICATION	STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO Cu(PSF)	TORVANE Cu(PSF)	TORVANE (REM) Cu(PSF)	SENSITIVITY	UNDISTURBED (PSF)	REMOLDED (PSF)	SENSITIVITY		
S-27	S-1	9-11	47.6					46		80	100						SC	II
	S-2	11-13	30.4															II
	S-3	16-18	32.2					24									SM	IIIa
	S-4	18-20																IIIa
	S-5	23.5-25	48.9			0	5	95		700	760	340	2.2				CL	IIIb
	S-6	28.5-30								700	640	340	1.9					IIIb
	S-7	33.5-35								1000	1000	540	1.9					IIIb
	S-8	38.5-40								1100	1000	400	2.5					IIIb

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TABLE-6: SUMMARY OF SLOPE STABILITY ANALYSIS

SHARPS ISLAND

E2CR PROJECT NO. 01583-04

Note : * Depth from the existing water surface at El. 0.00

AREA	METHOD	BOTTOM OF DIKE	TOP OF DIKE	TYPE OF FAILURE	COMPUTED FACTOR OF SAFETY
UN-ERODED GEOLOGIC AREA	BISHOP CIRCLE	El.-15	El.+20	SHALLOW	1.49
	BISHOP CIRCLE	El.-15	El.+20	DEEP	1.58
EROSION CHANNEL AREA	BISHOP CIRCLE	El.-15	El.+20	DEEP	0.88
	BISHOP CIRCLE	El.-15	El.+10	DEEP	1.07

APPENDIX-C

BORING LOGS

E2CR, INC.

BORING LOG

PROJECT			PROJECT NO.	BORING NO.
Sharps Island			01583-04	S - 1

SITE	BEGUN	COMPLETED	HOLE SIZE	GROUND ELEVATION
Chesapeake Bay, Maryland	01/14/02	01/14/02		0.0
COORDINATES	**DEPTH WATER ENC.**	**AT END DRILL**	**AT 24 HRS**	**CAVED DEPTH**
N: 38° 37.286' W: 76° 21.418'				
DRILLER	**WEIGHT OF HAMMER**	**HEIGHT OF FALL**	**TYPE OF CORE**	**DEPTH OF BORING**
J. Sies	140 lbs.	30.0"		60
TYPE OF DRILL RIG & METHOD	**DEPTH TO ROCK**	**LOGGED BY:**		**PAGE NO.**
HSA		C. Jacobs		1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 9.0' @ 8:00 a.m.
5	-5								
10	-10		Brownish gray, fine to medium SAND, trace Silt and Shell fragments (SP-SM)	S-1	24"	2-3-3-3	DS	6"	
			Orange brown and gray, wet, Silty CLAY, little fine Sand (CL)	S-2	24"	3-3-3-3	DS	16"	
15	-15								
				S-3	24"	2-2-3-5	DS	6"	
			Orange brown, fine to medium SAND, trace to little Silt (SP-SM)	S-4	24"	5-7-8-6	DS	16"	
20	-20								
				S-5	18"	2-3-4	DS	16"	
25	-25								
			Light brownish gray, Silty fine to medium SAND, trace Clay and Shell fragments (SM)						
				S-6	18"	4-8-11	DS	16"	
30	-30								
35	-35			S-7	18"	4-9-11	DS	16"	

E2CR, Inc.	BORING LOG	BORING NO. S - 1
PROJECT Sharps Island	PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Light brownish gray, Silty fine to medium SAND, trace Clay and Shell fragments (SM)						
				S-8	18"	2-3-3	DS	14"	
40	-40								
			Brownish gray, Silty fine to medium SAND, and GRAVEL (SM-GM)	S-9	6"	50/5"	DS	3"	
45	-45								
			Brownish gray, fine SAND, trace Silt and fine Gravel (SP-SM)						
				S-10	18"	4-6-8	DS	14"	
50	-50								
				S-11	18"	4-5-6	DS	18"	
55	-55								
			Brownish gray, moist, SILT and fine SAND (ML)						
				S-12	18"	5-7-7	DS	14"	
60	-60		Bottom of Boring @ 60.0 feet						
65	-65								
70	-70								
75	-75								

E2CR, INC.				BORING LOG	
PROJECT Sharps Island				PROJECT NO. 01583-04	BORING NO. S - 2
SITE Chesapeake Bay, Maryland	BEGUN 01/10/02	COMPLETED 01/10/02	HOLE SIZE		GROUND ELEVATION 0.0
COORDINATES N: 38° 37.584' W: 76° 21.086'	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS		CAVED DEPTH
DRILLER J. Sies	WEIGHT OF HAMMER 140 lbs.	HEIGHT OF FALL 30.0"	TYPE OF CORE		DEPTH OF BORING 75
TYPE OF DRILL RIG & METHOD HSA	DEPTH TO ROCK	LOGGED BY: C. Jacobs			PAGE NO. 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 10.0' @ 8:30 a.m.
5	-5								
10	-10		Brownish to medium gray, fine to medium SAND, trace Silt and Shell fragments (SP-SM)	S-1	24"	1-1-1-3	DS	4"	
				S-2	24"	3-2-2-3	DS	12"	
15	-15			S-3	24"	1-1-1-1	DS	6"	
				S-4	24"	2-2-2-2	DS	18"	
20	-20								
			Brownish gray, fine SAND and SILT (SM)						
25	-25			S-5	18"	WOR/18"	DS	18"	
30	-30			VS-1	6"	Vane Shear	VS		
				S-6	18"	WOR/18"	DS	15"	
35	-35			S-7	18"	WOR/18"	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. S - 2
PROJECT: Sharps Island	PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Brownish gray, fine SAND and SILT (SM)						
			Brownish gray, moist to very moist, Clayey SILT, little to trace fine Sand (MH)						
				S-8	18"	WOR/18"	DS	18"	
40	-40								
				VS-2	6"	Vane Shear	VS	-	
45	-45			ST-1	24"	Pushed Tube	ST	22"	
				VS-3	6"	Vane Shear	VS	-	
				S-9	18"	WOR/18"	DS	18"	
50	-50								
			Greenish gray, very moist, Silty CLAY (CL-CH)						
				S-10	18"	WOH/18"	DS	18"	
55	-55								
				S-11	18"	WOH/18"	DS	18"	
60	-60								
				S-12	18"	WOH/18"	DS	18"	
65	-65								
				S-13	18"	WOR/18"	DS	18"	
70	-70								
				S-14	18"	WOR/18"	DS	9"	
75	-75		Bottom of Boring @ 75.0 feet						

E2CR, INC.

BORING LOG

PROJECT: Sharps Island		PROJECT NO.: 01583-04		BORING NO.: S - 3
SITE: Chesapeake Bay, Maryland	BEGUN: 01/09/02	COMPLETED: 01/09/02	HOLE SIZE:	GROUND ELEVATION: 0.0
COORDINATES: N: 38° 37.996' W: 76° 21.391'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:	CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:	DEPTH OF BORING: 60
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 15.0' @ 12:30 p.m.
5	-5								
10	-10								
15	-15		Brownish gray, fine to medium SAND, trace Silt and Shell fragments (SP-SM)	S-1	24"	1-1-1-1	DS	3"	
				S-2	24"	3-4-4-4	DS	13"	
20	-20		Brownish gray, wet, Clayey SILT, little fine Sand (ML)	S-3	24"	WOR/24"	DS	10"	
				S-4	24"	WOR/24"	DS	20"	
25	-25		Orange brown, fine to medium SAND, trace Silt and fine to coarse Gravel (SM)						
				S-5	18"	7-8-18	DS	9"	
30	-30								
35	-35		Medium gray and orange brown,	S-6	18"	WOR/12"-4	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. S - 3
PROJECT Sharps Island	PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			moist, Clayey SILT, trace fine Sand and Iron staining (with a layer of Clayey fine Sand) (MH)	S-7	18"	WOR/18"	DS	18"	
40	-40		Greenish gray, very moist to moist, Silty CLAY (CL-CH)						
				S-8	18"	WOR/18"	DS	18"	
45	-45								
				S-9	18"	1-1-3	DS	18"	
50	-50								
				S-10	18"	5-5-6	DS	18"	
55	-55								
				S-11	18"	4-5-5	DS	18"	
60	-60		Bottom of Boring @ 60.0 feet						
65	-65								
70	-70								
75	-75								

E2CR, INC.				BORING LOG
PROJECT Sharps Island			PROJECT NO. 01583-04	BORING NO. S - 4
SITE Chesapeake Bay, Maryland	BEGUN 01/09/02	COMPLETED 01/09/02	HOLE SIZE	GROUND ELEVATION 0.0
COORDINATES N: 38° 38.280' W: 76° 21.926'	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS	CAVED DEPTH
DRILLER J. Sies	WEIGHT OF HAMMER 140 lbs.	HEIGHT OF FALL 30.0"	TYPE OF CORE	DEPTH OF BORING 60
TYPE OF DRILL RIG & METHOD HSA	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO. 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 16.0' @ 10:00 a.m.
5	-5								
10	-10								
15	-15								
			Greenish gray, very moist to wet, Clayey fine SAND (SC)	S-1	24"	WOR/24"	DS	16"	
				S-2	24"	WOR/24"	DS	24"	
20	-20								
				S-3	24"	WOR/24"	DS		
			Grayish brown, wet, SILT and fine SAND (with a layer of Silty Sand) (ML)	S-4	24"	4-4-4-4	DS	18"	
25	-25								
			Greenish to brownish gray, very moist to moist, Silty CLAY (with occasional Peat lenses) (CL-CH)	VS-1	6"	Vane Shear	VS	-	
				ST-1	18"	Pushed Tube	ST	NR	
				S-5	18"	2-2-2	DS	16"	
30	-30			VS-2	6"	Vane Shear	VS	-	
				ST-2	24"	Pushed Tube	ST	12"	
				S-6	18"	WOR/18"	DS	18"	
35	-35								

E2CR, Inc.	BORING LOG	BORING NO. S - 4
PROJECT: Sharps Island	PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish to brownish gray, very moist to moist, Silty CLAY (with occasional Peat lenses) (CL-CH)						
				S-7	18"	WOR/18"	DS	18"	
40	-40								
				S-8	18"	WOR/18"	DS	18"	
45	-45								
				S-9	18"	WOR/18"	DS	18"	
50	-50								
			Grayish brown, moist, SILT and fine SAND (ML)						
				S-10	18"	5-7-8	DS	17"	
55	-55								
			Grayish brown, Silty fine SAND (SM)						
				S-11	18"	6-6-7	DS	10"	
60	-60		Bottom of Boring @ 60.0 feet						
65	-65								
70	-70								
75	-75								

E2CR, INC.				BORING LOG
PROJECT: Sharps Island			PROJECT NO.: 01583-04	BORING NO.: S - 5
SITE: Chesapeake Bay, Maryland	BEGUN: 01/18/02	COMPLETED: 01/18/02	HOLE SIZE:	GROUND ELEVATION: 0.0
COORDINATES: N: 38° 38.271' W: 76° 22.384'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:	CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:	DEPTH OF BORING: 60
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 13.4' @ 8:00 a.m.
5	-5								
10	-10								
			Light greenish gray to orange brown, wet, Clayey fine to medium SAND, trace Shell fragments (SC)	S-1	24"	2-2-2-2	DS	3"	
15	-15			S-2	24"	1-1-1-1	DS	19"	
			Orange brown, Silty fine to coarse SAND and GRAVEL (GM)	S-3	24"	18-5-5-5	DS	9"	
20	-20		Green to brown, Silty fine to medium SAND, trace fine Gravel and Shell fragments (SM)	S-4	24"	37-50/3"	DS		
25	-25		Greenish gray, Silty to Shelly fine to medium SAND, trace coarse Sand, fine Gravel and Clay (Clay increasing with depth) (SM)	S-5	18"	5-7-7	DS	18"	
				S-6	18"	10-12-14	DS	10"	
30	-30		Greenish gray, Silty fine SAND (SM)						
35	-35			S-7	18"	8-9-15	DS	18"	

E2CR, Inc. — BORING LOG

BORING NO.	PROJECT	PROJECT NO.	PAGE
S - 5	Sharps Island	01583-04	2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray, Silty fine SAND (SM)						
				S-8	18"	10-12-17	DS	18"	
40	-40								
				S-9	18"	10-18-25	DS	18"	
45	-45								
			Greenish gray, moist, SILT and fine SAND (ML)						
				S-10	18"	9-19-23	DS	18"	
50	-50								
				S-11	18"	18-23-28	DS	18"	
55	-55								
				S-12	18"	15-25-30	DS	18"	
60	-60		Bottom of Boring @ 60.0 feet						
65	-65								
70	-70								
75	-75								

E2CR, INC.					BORING LOG
PROJECT: Sharps Island			PROJECT NO.: 01583-04		BORING NO.: S - 6
SITE: Chesapeake Bay, Maryland	BEGUN: 01/18/02	COMPLETED: 01/18/02	HOLE SIZE:		GROUND ELEVATION: 0.0
COORDINATES: N: 38° 37.918' W: 76° 22.906'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:		CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:		DEPTH OF BORING: 60
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs			PAGE NO. 1 OF 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 14.4' @ 11:00 a.m.
5	-5								
10	-10								
15	-15		Medium gray and orange brown, wet, Clayey fine to medium SAND (SC)	S-1	24"	1- 1- 1- 4	DS	13"	
				S-2	24"	3- 3- 3- 3	DS	22"	
20	-20		Medium brown, moist to very moist, Clayey SILT, little organics (MH)	S-3	24"	2- 3- 3- 3	DS	20"	
			Dark brown and black, Silty SAND, trace to little organics, peat (SM)	S-4	24"	3- 3- 4- 4	DS	16"	
25	-25								
			Grayish brown, Silty fine to medium SAND, trace fine to coarse Gravel (with a layer of Gravel) (SM)	S-5	18"	8- 14- 10	DS	15"	
30	-30		Greenish gray, Silty fine SAND (SM)						
35	-35			S-6	18"	7- 9- 14	DS	13"	

E2CR, Inc.	BORING LOG	BORING NO. S - 6	
PROJECT Sharps Island		PROJECT NO. 01583-04	PAGE 2 OF 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray, Silty fine SAND (SM)						
40	-40			S-7	18"	8- 13- 20	DS	18"	
45	-45			S-8	18"	15-32-50/ 3"	DS	15"	
50	-50			S-9	18"	32-50/5"	DS	11"	
55	-55			S-10	18"	8-15-20	DS	18"	
60	-60			S-11	18"	10-23-28	DS	18"	
			Bottom of Boring @ 60.0 feet						
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Sharps Island				PROJECT NO.: 01583-04	BORING NO.: S - 7
SITE: Chesapeake Bay, Maryland	BEGUN: 01/23/02	COMPLETED: 01/23/02	HOLE SIZE:		GROUND ELEVATION: 0.0
COORDINATES: N: 38° 37.509' W: 76° 23.083'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:		CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:		DEPTH OF BORING: 55.8
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs			PAGE NO. 1 OF 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 15.0' @ 8:00 a.m.
5	-5								
10	-10								
15	-15		Brownish green, Silty fine to medium SAND, trace Shell fragments (SM)	S-1	24"	1-1-1-1	DS	12"	
			Medium gray and orange brown, moist, Clayey SAND, trace Shell fragments (SC)	S-2	24"	2-2-2-2	DS	12"	
20	-20		Orange brown, fine to coarse SAND, little Gravel, trace Silt (SP-SM)	S-3	24"	11-18-21-26	DS	4"	
				S-4	24"	4-5-9-6	DS	6"	
25	-25								
			Greenish gray, Silty fine to medium SAND, trace Shell fragments (SM)	S-5	18"	50/4"	DS	4"	
30	-30								
			Greenish gray, fine SAND, trace Silt (SP-SM)	S-6	18"	28-50/3"	DS	8"	
35	-35								

E2CR, Inc. — BORING LOG

BORING NO. S - 7

PROJECT: Sharps Island

PROJECT NO. 01583-04

PAGE 2 OF 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray, fine SAND, trace Silt (SP-SM)						
40	-40			S-7	18"	5- 7- 9	DS	16"	
45	-45			S-8	18"	14-15-16	DS	16"	
			Greenish gray, moist, Sandy CLAY (CL)						
50	-50			S-9	18"	17-20-25	DS	14"	
55	-55			S-10	18"	10-24-50/ 4"	DS	14"	Auger Refusal @ 55.8 feet
				S-11	6"	50/3"	DS	3"	
			Bottom of Boring @ 55.8 feet						
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.				BORING LOG
PROJECT Sharps Island			PROJECT NO. 01583-04	BORING NO. S - 8
SITE Chesapeake Bay, Maryland	BEGUN 01/22/02	COMPLETED 01/22/02	HOLE SIZE	GROUND ELEVATION 0.0
COORDINATES N: 38° 36.975' W: 76° 23.161'	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS	CAVED DEPTH
DRILLER J. Sies	WEIGHT OF HAMMER 140 lbs.	HEIGHT OF FALL 30.0"	TYPE OF CORE	DEPTH OF BORING 32
TYPE OF DRILL RIG & METHOD HSA	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO. 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 15.0' @ 12:00 noon
5	-5								
10	-10								
15	-15		Grayish green, Silty SAND, little Shell fragments (SM)	S-1	24"	1-1-1-1	DS	12"	
			Orange brown and gray, moist, Clayey SAND, trace Shell fragments (SC)	S-2	24"	1-1-2-3	DS	12"	
20	-20		Orange brown, Silty fine to medium SAND, trace Shell fragments (SM)	S-3	24"	7-10-5-4	DS	14"	
				S-4	24"	3-3-4-5	DS	16"	
25	-25								
				S-5	18"	10-12-14	DS	18"	
30	-30								Auger Refusal @ 32.0 feet
			Bottom of Boring @ 32.0 feet						
35	-35								

E2CR, INC.

BORING LOG

PROJECT: Sharps Island			PROJECT NO.: 01583-04		BORING NO.: S - 9
SITE: Chesapeake Bay, Maryland	BEGUN: 01/22/02	COMPLETED: 01/22/02	HOLE SIZE:		GROUND ELEVATION: 0.0
COORDINATES: N: 38° 36.412' W: 76° 23.127'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:		CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:		DEPTH OF BORING: 40
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs			PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 13.0' @ 10:00 a.m.
5	-5								
10	-10								
			Orange brown and gray, moist, Clayey SAND, trace Shell fragments (SC)	S-1	24"	1-1-2-2	DS	12"	
15	-15		Orange brown and gray, moist, Silty CLAY, little Gravel and Sand (CL)	S-2	24"	2-2-2-2	DS	16"	
			Greenish dark brown, moist, Clayey SAND, trace Shell fragments (SC)	S-3	24"	2-2-2-2	DS	18"	
20	-20			S-4	24"	2-2-3-3	DS	16"	
			Greenish brown to greenish gray, Silty SAND, trace Shell fragments (SM)						
25	-25			S-5	18"	4-6-11	DS	16"	
30	-30			S-6	18"	6-8-8	DS	16"	
35	-35			S-7	18"	7- 9- 9	DS	16"	

E2CR, Inc.	BORING LOG	BORING NO. S - 9
PROJECT Sharps Island	PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish brown to greenish gray, Silty SAND, trace Shell fragments (SM)	S-8	18"	50/2"	DS	2"	Auger Refusal @ 40.0 feet
40	-40		Bottom of Boring @ 40.0 feet						
45	-45								
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT	PROJECT NO.	BORING NO.
Sharps Island	01583-04	S - 10

SITE	BEGUN	COMPLETED	HOLE SIZE	GROUND ELEVATION
Chesapeake Bay, Maryland	01/22/02	01/22/02		0.0

COORDINATES	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS	CAVED DEPTH
N: 38° 35.887' W: 76° 23.099'				

DRILLER	WEIGHT OF HAMMER	HEIGHT OF FALL	TYPE OF CORE	DEPTH OF BORING
J. Sies	140 lbs.	30.0"		47

TYPE OF DRILL RIG & METHOD	DEPTH TO ROCK	LOGGED BY:	PAGE NO.	OF
HSA		C. Jacobs	1	2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 11. 0" @ 2:00 p.m.
5	-5								
10	-10								
			Orange brown and gray, moist, Clayey SAND, trace Gravel, trace Shell fragments (SC)	S-1	24"	WOH/24"	DS	6"	
15	-15			S-2	24"	2-2-2-2	DS	16"	
				S-3	24"	1-1-1-2	DS	6"	
			Orange brown, fine to medium SAND, trace Silt and Gravel (SP-SM)	S-4	24"	2-2-2-6	DS	11"	
20	-20								
			Greenish dark brown, moist, Silty CLAY, little Sand, trace shell fragments and mica (CL)	S-5	18"	15-18-21	DS	18"	
25	-25								
			Greenish brown, fine SAND and SILT, trace to little Clay, Shell fragments and organics (SM)	S-6	18"	5-8-16	DS	14"	
30	-30								
			Greenish dark brown, moist, Silty CLAY, little Sand, trace	S-7	18"	10-12-14	DS	14"	
35	-35								

E2CR, Inc.	BORING LOG	BORING NO. S - 10	
PROJECT Sharps Island		PROJECT NO. 01583-04	PAGE 2 OF 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Shell fragments and mica (CL)						
			Greenish brown, moist, Clayey SAND, little Shell fragments, trace mica (SC)	S-8	18"	6-7-12	DS	14"	
40	-40								
				S-9	18"	7-11-12	DS	12"	
45	-45								Auger Refusal @ 47.0 feet
			Bottom of Boring @ 47.0 feet						
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Sharps Island				PROJECT NO.: 01583-04	BORING NO.: S - 11
SITE: Chesapeake Bay, Maryland	BEGUN: 01/16/02	COMPLETED: 01/16/02	HOLE SIZE:		GROUND ELEVATION: 0.0
COORDINATES: N: 38° 35.440' W: 76° 22.826'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:		CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:		DEPTH OF BORING: 50
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs			PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 11.0' @ 12:00 noon
5	-5								
10	-10								
			Brownish gray, fine to medium SAND, trace Silt and Shell fragments (SP-SM)	S-1	24"	2-2-2-3	DS	6"	
				S-2	24"	3-3-3-3	DS	6"	
15	-15								
				S-3	24"	2-2-2-2	DS	12"	
			Brownish gray, Silty fine SAND (SM)	S-4	24"	1-2-1-2	DS	5"	
20	-20								
			Light greenish gray, moist, Clayey SILT and fine Sand (MH)						
				S-5	18"	2-2-3	DS	18"	
25	-25								
				S-6	18"	2-2-2	DS	18"	
30	-30								
			Orange brown, Silty fine to medium SAND (SM)						
35	-35			S-7	18"	1-1-1	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. S - 11
PROJECT Sharps Island	PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Orange brown, Silty fine to medium SAND (SM)						
			Orange brown, fine to medium SAND, trace Silt and Shell fragments (SP-SM)	S-8	18"	WOH/18"	DS	12"	
40	-40								
				S-9	18"	5-7-12	DS	18"	
45	-45								
				S-10	18"	5-6-8	DS	18"	
50	-50		Bottom of Boring @ 50.0 feet						
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.				BORING LOG
PROJECT Sharps Island			PROJECT NO. 01583-04	BORING NO. S - 12
SITE Chesapeake Bay, Maryland	BEGUN 01/14/02	COMPLETED 01/14/02	HOLE SIZE	GROUND ELEVATION 0.0
COORDINATES N: 38° 35.873' W: 76° 22.385'	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS	CAVED DEPTH
DRILLER J. Sies	WEIGHT OF HAMMER 140 lbs.	HEIGHT OF FALL 30.0"	TYPE OF CORE	DEPTH OF BORING 50.5
TYPE OF DRILL RIG & METHOD HSA	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO. 1 OF 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA					REMARKS:
				SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	
0	0		Water						Water depth 12' @ 10:45 a.m.
5	-5								
10	-10								
			Dark gray to brownish gray, Silty SAND, trace Shell fragments (SM)	S-1	24"	2-3-2-2	DS	20"	
15	-15			S-2	24"	5-3-3-5	DS	24"	
				S-3	24"	5-5-5-5	DS	24"	
				S-4	24"	WOH/12"-1-2	DS	16"	
20	-20		Dark gray to brownish gray Silty SAND, little Clay (SM)	S-5	24"	WOR/24"	DS	24"	
			Grayish brown, moist, fine Sandy SILT, trace to little Clay (ML)						
25	-25			S-6	24"	WOR/24"	DS	24"	
30	-30			S-7	24"	WOR/24"	DS	24"	
35	-35			S-8	24"	WOR/24"	DS	24"	

E2CR, Inc.	BORING LOG	BORING NO. S - 12	
PROJECT Sharps Island		PROJECT NO. 01583-04	PAGE 2 OF 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Grayish brown, moist, fine Sandy SILT, trace to little Clay (ML)						
40	-40			S-9	24"	WOR/24"	DS	24"	
			Grayish brown, moist, Clayey SILT, little fine Sand (MH)						
45	-45			S-10	24"	WOR/24"	DS	24"	
50	-50			S-11	24"	WOR/24"	DS	24"	
			Bottom of Boring @ 50.5 feet						
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT				PROJECT NO.	BORING NO.
Sharps Island				01583-04	S - 13
SITE: Chesapeake Bay, Maryland	BEGUN: 01/16/02	COMPLETED: 01/16/02	HOLE SIZE:		GROUND ELEVATION: 0.0
COORDINATES: N: 38° 36.275' W: 76° 21.965'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:		CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:		DEPTH OF BORING: 55
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs			PAGE NO. 1 OF 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 11. 0' @ 8:00 a.m.
5	-5								
10	-10								
			Dark gray and brown, Silty fine to medium SAND, trace Shell fragments (SM)	S-1	24"	1-1-2-2	DS	3"	
				S-2	24"	2-2-2-2	DS	3"	
15	-15								
				S-3	24"	2-1-1-1	DS	6"	
			Dark gray, wet, Clayey SILT and fine SAND (ML)	S-4	24"	1-1-1-1	DS	24"	
20	-20								
			Greenish gray, very moist, Silty CLAY, trace to little fine Sand (CL)						
25	-25			S-5	18"	WOR/18"	DS	18"	
				S-6	18"	WOR/18"	DS	18"	
30	-30								
			Greenish gray, fine SAND and SILT, trace to little Clay and Shell fragments (SM-ML)	S-7	18"	WOR/18"	DS	18"	
35	-35								

E2CR, Inc.	BORING LOG	BORING NO. S - 13	
PROJECT Sharps Island		PROJECT NO. 01583-04	PAGE 2 OF 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray, fine SAND and SILT, trace to little Clay and Shell fragments (SM-ML)						
40	-40			S-8	18"	WOR/18"	DS	18"	
			Brownish gray, Silty fine to medium SAND, trace coarse Sand, Shell fragments and Clay (SM)						
45	-45			S-9	18"	2- 2- 2	DS	18"	
			Greenish brown, fine SAND, trace Silt (SP-SM)						
50	-50			S-10	18"	3- 5- 7	DS	16"	
			Greenish brown, Silty fine to coarse GRAVEL and SAND (GM)	S-11	6"	50/3"	DS	1"	Auger Refusal @ 55.0 feet
55	-55		Bottom of Boring @ 55.0 feet						
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT			PROJECT NO.	BORING NO.
Sharps Island			01583-04	S - 14
SITE: Chesapeake Bay, Maryland	BEGUN: 01/15/02	COMPLETED: 01/15/02	HOLE SIZE:	GROUND ELEVATION: 0.0
COORDINATES: N: 38° 36.753' W: 76° 21.974'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:	CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:	DEPTH OF BORING: 44.3
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs		PAGE NO. 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 9.3' @ 12:30 p.m.
5	-5								
10	-10		Medium gray and brown, wet, Clayey fine to medium SAND, trace coarse Sand and fine Gravel (SC)	S-1	24"	WOR/24"	DS	14"	
				S-2	24"	1-1-2-1	DS	20"	
15	-15		Orange brown, Silty fine to medium SAND (SM)						
			Orange brown, Silty fine to coarse GRAVEL and SAND (GM)	S-3	24"	6-8-15-30	DS	8"	
				S-4	6"	50/4"	DS	4"	
20	-20								
			Greenish gray, moist, fine Sandy SILT, trace Clay (ML)						
25	-25			S-5	18"	10-15-20	DS	16"	
			Orange brown, Silty fine to medium SAND, trace coarse Sand and fine Gravel (SM)						
30	-30			S-6	18"	5-11-14	DS	10"	
			Grayish brown, Silty fine to coarse SAND, trace Shell fragments and Clay (SM)						
35	-35			S-7	18"	10-22-28	DS	18"	

E2CR, Inc. BORING LOG

PROJECT	PROJECT NO.	PAGE	BORING NO.
Sharps Island	01583-04	2	S - 14

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Grayish brown, Silty fine to coarse SAND, trace Shell fragments and Clay (SM)						
				S-8	18"	5- 7- 9	DS	18"	
40	-40								
				S-9	9"	15/50/3"	DS	8"	Auger Refusal @ 44.3 feet
45	-45		Bottom of Boring @ 44.3 feet						
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Sharps Island			PROJECT NO.: 01583-04		BORING NO.: S - 15
SITE: Chesapeake Bay, Maryland	BEGUN: 01/15/02	COMPLETED: 01/15/02	HOLE SIZE:		GROUND ELEVATION: 0.0
COORDINATES: N: 38° 37.236' W: 76° 21.988'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:		CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:		DEPTH OF BORING: 42
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs			PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth @ 9.0' @ 10:30 a.m.
5	-5								
10	-10		Dark gray and brown, Silty fine to medium SAND (SM)	S-1	24"	2-2-2-2	DS	7"	
			Medium gray and brown, wet, Clayey to Silty fine to medium SAND (with occasional layers of Sandy Clay) (SC)	S-2	24"	2-2-2-2	DS	24"	
15	-15								
				S-3	24"	2-3-5-5	DS	20"	
				S-4	24"	8-9-10-11	DS	18"	
20	-20		Grayish brown, fine to medium SAND, trace Silt (SP-SM)						
			Brownish gray, Silty fine to medium SAND (with a layer of Silty fine to coarse Sand @ 30.0') (SM)	S-5	18"	7- 8- 10	DS	10"	
25	-25								
				S-6	18"	36-12-12	DS	12"	
30	-30								
				S-7	18"	3- 4- 10	DS	18"	
35	-35								

E2CR, Inc.

BORING LOG

BORING NO. S - 15

PROJECT: Sharps Island

PROJECT NO. 01583-04

PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Brownish gray, Silty fine to medium SAND (with a layer of Silty fine to coarse Sand @ 30.0') (SM)						
			Brownish gray, Silty fine to coarse GRAVEL and SAND (GM)	S-8	6"	50/0"	DS	0	
40	-40								Auger Refusal @ 42.0 feet
			Bottom of Boring @ 42.0 feet						
45	-45								
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Sharps Island			PROJECT NO.: 01583-04		BORING NO.: S - 16
SITE: Chesapeake Bay, Maryland	BEGUN: 01/10/02	COMPLETED: 01/10/02	HOLE SIZE:		GROUND ELEVATION: 0.0
COORDINATES: N: 38° 37.632' W: 76° 21.552'	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS		CAVED DEPTH
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL.: 30.0"	TYPE OF CORE		DEPTH OF BORING: 60
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK	LOGGED BY: C. Jacobs			PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 11.0' @ 1:00 p.m.
5	-5								
10	-10								
			Medium gray and orange brown, Clayey fine to medium SAND (with occasional layers of Silty Sand) (SC)	S-1	24"	2-2-2-1	DS	6"	
				S-2	24"	2-2-2-2	DS	20"	
15	-15								
				S-3	24"	WOR/24"	DS	12"	
				S-4	24"	WOH/24"	DS	18"	
20	-20		Light brown and gray, fine to medium SAND, trace coarse Gravel and Silt (with a Gravel layer from 22.0-24.0') (SM)						
				S-5	18"	10-15-19	DS	16"	
25	-25								
			Greenish gray, Clayey SILT, trace of fine Sand (MH)						
				S-6	18"	WOR/18"	DS	18"	
30	-30								
				S-7	18"	2- 3- 4	DS	18"	
35	-35								

E2CR, Inc.	BORING LOG	BORING NO. S - 16
PROJECT Sharps Island	PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray, moist, Clayey SILT, trace of fine Sand (MH)						
			Brownish gray, Dense, Silty fine to medium SAND (SM)	S-8	6"	50/5"	DS	4"	
40	-40								
			Greenish gray, Silty fine SAND (SM)	S-9	18"	1- 1- 3	DS	18"	
45	-45		Greenish gray, moist, SILT and fine SAND, trace Shell fragments (with occasional layers of fine Sand and Silt) (ML)						
				S-10	18"	5- 8- 19	DS	18"	
50	-50								
				S-11	18"	12- 18- 30	DS	18"	
55	-55								
				S-12	18"	15-25-38	DS	18"	
60	-60		Bottom of Boring @ 60.0 feet						
65	-65								
70	-70								
75	-75								

E2CR, INC.				BORING LOG
PROJECT Sharps Island			PROJECT NO. 01583-04	BORING NO. S - 17
SITE Chesapeake Bay, Maryland	BEGUN 01/15/02	COMPLETED 01/15/02	HOLE SIZE	GROUND ELEVATION 0.0
COORDINATES N: 38° 37.796' W: 76° 21.941'	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS	CAVED DEPTH
DRILLER J. Sies	WEIGHT OF HAMMER 140 lbs.	HEIGHT OF FALL 30.0"	TYPE OF CORE	DEPTH OF BORING 45
TYPE OF DRILL RIG & METHOD HSA	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO. 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 11.0' @ 11:00 a.m.
5	-5								
10	-10								
			Medium gray and brown, fine to medium SAND, trace Silt and Shell fragments (SP SM)-	S-1	24"	2-2-2-2	DS	6"	
			Medium gray and brown, wet, Clayey fine to medium SAND (SC)	S-2	24"	2-2-3-4	DS	6"	
15	-15								
				S-3	24"	WOR/24"	DS	16"	
				S-4	24"	WOR/24"	DS	16"	
20	-20								
			Greenish gray, moist, Clayey SILT, trace fine Sand (with layers of Sandy Clay) (MH)						
				S-5	18"	2- 3- 4	DS	16"	
25	-25			ST-1	24"	Pushed Tube	ST	12.5"	
				S-6	18"	3- 3- 3	DS	16"	
30	-30								
35	-35			S-7	18"	3- 3- 3	DS	14"	

E2CR, Inc.	BORING LOG	BORING NO. S-17	
PROJECT Sharps Island		PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray, moist, Clayey SILT, trace fine Sand (with layers of Sandy Clay) (MH)						
			Greenish gray, Silty fine to medium SAND, trace to little fine to coarse Gravel (SM)	S-8	18"	16-7-5	DS	18"	
40	-40								
				S-9	18"	9-15-25	DS	18"	
45	-45		Greenish gray, moist, fine Sandy SILT (ML)						
			Bottom of Boring @ 45.0 feet						
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.				BORING LOG	
PROJECT: Sharps Island				PROJECT NO.: 01583-04	BORING NO.: S - 18
SITE: Chesapeake Bay, Maryland	BEGUN: 01/29/02	COMPLETED: 01/29/02	HOLE SIZE:		GROUND ELEVATION: 0.0
COORDINATES: N: 38° 37.566' W: 76° 22.527'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:		CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:		DEPTH OF BORING: 40
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs			PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 11.2' @ 8:30 a.m.
5	-5								
10	-10								
			Medium to greenish gray, very moist to wet, Silty CLAY, trace to little fine Sand (with occasional Shelly layers) (CL-CH)	S-1	24"	WOR/24"	DS	3"	
				S-2	24"	1-1-2-2	DS	24"	
15	-15								
			Greenish gray, wet, Clayey fine SAND (SC)	S-3	21"	WOR/24"	DS	21"	
				S-4	24"	WOR/24"	DS	22"	
20	-20								
			Greenish gray, fine to medium SAND, trace to little Clay, Shells (SM)						
				S-5	18"	15-8-12	DS	18"	
25	-25								
				S-6	18"	4- 5- 8	DS	12"	
30	-30								
			Greenish gray, Silty fine SAND (SM)						
35	-35			S-7	18"	7-21-36	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. S - 18	
PROJECT Sharps Island		PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray, fine SAND and SILT (SM)						
40	-40			S-8	18"	10-12-20	Ds	18"	
			Bottom of Boring @ 40.0 feet						
45	-45								
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.				BORING LOG
PROJECT: Sharps Island			PROJECT NO.: 01583-04	BORING NO.: S - 19
SITE: Chesapeake Bay, Maryland	BEGUN: 01/18/02	COMPLETED: 01/18/02	HOLE SIZE:	GROUND ELEVATION: 0.0
COORDINATES: N: 38° 37.044' W: 76° 22.480'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:	CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:	DEPTH OF BORING: 43
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 12.0' @ 9:30 a.m.
5	-5								
10	-10								
			Greenish gray, moist, Silty CLAY, some Sand, trace Shell fragments (CL)	S-1	24"	WOH/12"-1-3	DS	24"	
15	-15			S-2	24"	1-1-1-1	DS	24"	
				S-3	24"	WOH/24"	DS	24"	
				ST-1	24"	Pushed Tube	ST	24"	
20	-20		Orange brown and gray, moist, Silty CLAY and SAND (CL)	S-4	24"	3-3-4-4	DS	24"	
			Orange brown and gray, fine SAND, little Clay, trace Shell fragments (SM-SC)	S-5	18"	4- 8- 9	DS	18"	
25	-25								
				S-6	18"	2-1-WOH/6"	DS	18"	
30	-30			ST-2	24"	Pushed Tube	ST	NR	
			Orange brown to greenish brown, Silty fine SAND, trace Clay and Shell fragments (SM)	S-7	18"	18-31-39	DS	18"	
35	-35								

E2CR, Inc.	BORING LOG	BORING NO. S - 19	
PROJECT Sharps Island		PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Orange brown to greenish brown, Silty fine SAND, trace Clay and Shell fragments (SM)						
			Greenish brown, Silty fine SAND, trace Clay and Shell fragments (SM)	S-8	18"	23-50/4"	DS	10"	
40	-40								
									Auger Refusal @ 43.0 feet
			Bottom of Boring @ 43.0 feet						
45	-45								
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Sharps Island			PROJECT NO.: 01583-04	BORING NO.: S - 20
SITE: Chesapeake Bay, Maryland	BEGUN: 01/28/02	COMPLETED: 01/28/02	HOLE SIZE:	GROUND ELEVATION: 0.0
COORDINATES: N: 38° 36.459' W: 76° 22.358'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:	CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:	DEPTH OF BORING: 30
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 11.7' @ 11:00 a.m.
5	-5								
10	-10								
			Orange brown and gray, wet, Clayey fine to medium SAND (with 6" layers of Silty Sand) (SC)	S-1	24"	1-1-1-4	DS	20"	
15	-15			S-2	24"	10-18-20-24	DS	18"	
			Greenish gray, moist, Silty CLAY, little fine Sand (CL)	S-3	24"	5-8-8-10	DS	19"	
20	-20			S-4	24"	10-18-20-23	DS	18"	
25	-25			S-5	18"	9-15-18	DS	12"	
				S-6	18"	6-9-14	DS	18"	
30	-30		Bottom of Boring @ 30.0 feet						
35	-35								

E2CR, INC.

BORING LOG

PROJECT Sharps Island			PROJECT NO. 01583-04	BORING NO. S - 21
SITE Chesapeake Bay, Maryland	BEGUN 01/22/02	COMPLETED 01/22/02	HOLE SIZE	GROUND ELEVATION 0.0
COORDINATES N: 38° 36.190' W: 76° 22.835'	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS	CAVED DEPTH
DRILLER J. Sies	WEIGHT OF HAMMER 140 lbs.	HEIGHT OF FALL 30.0"	TYPE OF CORE	DEPTH OF BORING 42.5
TYPE OF DRILL RIG & METHOD HSA	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO. 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 11.0'
5	-5								
10	-10								
			Dark gray, moist, Clayey SAND, little Shell fragments (SC)	S-1	24"	WOH/24"	DS	4"	
			Dark gray, fine SAND, little Shell fragments (SC)	S-2	24"	2- 2- 2- 2	DS	3"	
15	-15								
			Orange brown and gray, moist, Clayey fine to medium SAND, trace Gravel (SC)	S-3	24"	WOH/24"	DS	14"	
				S-4	24"	1- 1- 1- 1	DS	12"	
20	-20								
			Grayish brown, moist, Silty CLAY (CL)						
				S-5	18"	1- 1- 1	DS	18"	
25	-25								
				S-6	18"	1- 2- 2	DS	18"	
30	-30								
			Greenish gray to brownish gray, fine to medium SAND, little Silt (SM)						
35	-35			S-7	18"	4- 5- 6	DS	14'	

E2CR, Inc.	BORING LOG	BORING NO. S - 21	
PROJECT Sharps Island		PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray to brownish gray, fine to medium SAND, little Silt (SM)						
				S-8	18"	5- 6- 6	DS	14"	
40	-40								Auger Refusal @ 42.5 feet
				S-9	6"	50/5"	DS	0.5"	
			Bottom of Boring @ 42.5 feet						
45	-45								
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Sharps Island			PROJECT NO.: 01583-04		BORING NO.: S - 22
SITE: Chesapeake Bay, Maryland	BEGUN: 01/16/02	COMPLETED: 01/16/02	HOLE SIZE:		GROUND ELEVATION: 0.0
COORDINATES: N: 38° 35.788' W: 76° 22.822'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:		CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:		DEPTH OF BORING: 52
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs			PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0	Water						Water depth 11.0' @ 12:00 p.m.
5	-5							
10	-10							
		Orange brown and gray, Silty fine to medium SAND, little Shell fragments (SM)	S-1	24"	7- 8- 5- 4	DS	24"	
			S-2	24"	1- 1- 1- 1	DS	24"	
15	-15	Orange brown and gray, Silty fine to medium SAND, trace Gravel (SM)	S-3	24"	1-5-6-14	DS	24"	
			S-4	24"	17-8-5-6	DS	24"	
		Gray, Silty CLAY (CL)						
20	-20	Orange brown, Silty fine to medium SAND, little Gravel (SM)	S-5	24"	5- 6- 6- 7	DS	24"	
		Light orange brown, moist, SILT and fine SAND, trace Clay and mica (ML)						
25	-25		S-6	18"	16-14-16	DS	18"	
		Orange brown to greenish brown, Silty CLAY, trace fine Sand (CL)						
30	-30		S-7	18"	7- 7- 8	DS	18"	
		Orange brown to greenish brown, Silty fine to medium SAND, trace Shell frag. (SM)						
35	-35		S-8	18"	12-16-19	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. S - 22	
PROJECT Sharps Island		PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Orange brown to greenish brown, Silty fine to medium SAND, trace Shell fragments (SM)	S-9	18"	9-14-18	DS	18"	
40	-40		Greenish gray, Silty fine to medium SAND with white layers or lime and Shell fragments (SM)	S-10	18"	13-13-20	DS	18"	
45	-45								
				S-11	18"	12-17-25	DS	18"	
50	-50								
			Auger Refusal @ 52.0 feet						
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Sharps Island		PROJECT NO.: 01583-04		BORING NO.: S - 23
SITE: Chesapeake Bay, Maryland	BEGUN: 01/15/02	COMPLETED: 01/15/02	HOLE SIZE:	GROUND ELEVATION: 0.0
COORDINATES: N: 38° 36.544' W: 76° 21.485'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:	CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:	DEPTH OF BORING: 32
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs		PAGE NO. 1 OF 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 8.5' @ 11:30 a.m.
5	-5								
			Gray, moist, Silty CLAY (CL)	S-1	18"	WOH/18"	DS	14"	
10	-10		Dark gray, Silty SAND, trace Shell fragments (SM)	S-2	24"	5- 4- 3- 2	DS	12"	
				S-3	24"	1- 1- 1- 1	DS	18"	
15	-15		Dark gray, very moist, fine Sandy SILT (ML)	S-4	24"	WOH/24"	DS	24"	
				S-5	24"	2/24"	DS	0	
			Dark gray, Silty SAND, trace Shell fragments (SM)	S-6	24"	WOH/24"	DS	8"	
20	-20		Greenish brown, moist, Silty CLAY, little fine Sand (CL)						
25	-25			S-7	18"	9- 10- 12	DS	18"	
30	-30			S-8	18"	12-21-25	DS	18"	Auger Refusal @ 32.0 feet
			Bottom of Boring @ 32.0 feet						
35	-35								

E2CR, INC.				BORING LOG
PROJECT: Sharps Island			PROJECT NO.: 01583-04	BORING NO.: S - 24
SITE: Chesapeake Bay, Maryland	BEGUN: 01/15/02	COMPLETED: 01/15/02	HOLE SIZE:	GROUND ELEVATION: 0.0
COORDINATES: N: 38° 37.002' W: 76° 21.109'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:	CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:	DEPTH OF BORING: 55
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 10.0' @ 9:45 a.m.
5	-5								
10	-10		Dark gray, Silty fine SAND, trace Shell fragments (SM)	S-1	24"	2- 2- 2- 2	DS	16"	
				S-2	24"	1- 1- 1- 1	DS	8"	
15	-15			S-3	24"	2- 3- 4- 3	DS	18"	
				S-4	24"	WOR/24"	DS	8"	
				S-5	24"	2- 1- 3- 4	DS	24"	
20	-20								
			Greenish gray to greenish brown, moist to wet, Silty CLAY, little fine Sand, trace Shell fragments (CL)						
25	-25			S-6	18"	3- 3- 2	DS	14"	
				S-7	18"	11- 2- 3	DS	18"	
30	-30								
35	-35			S-8	18"	4- 4- 5	DS	18"	

E2CR, Inc. — BORING LOG

BORING NO.	S - 24		
PROJECT	Sharps Island	PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray to greenish brown, moist to wet, Silty CLAY, little fine Sand, trace Shell fragments (CL)						
40	-40			S-9	18"	7- 12- 12	DS	18"	
45	-45			S-10	18"	3- 3- 3	DS	18"	
50	-50			S-11	18"	WOR/18"	DS	18"	
			Greenish gray, moist, Silty CLAY (CL)						
55	-55			S-12	18"	WOR/18"	DS	18"	
			Bottom of Boring @ 55.0 feet						
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT			PROJECT NO.	BORING NO.
Sharps Island			01583-04	S - 25
SITE: Chesapeake Bay, Maryland	BEGUN: 01/29/02	COMPLETED: 01/29/02	HOLE SIZE:	GROUND ELEVATION: 0.0
COORDINATES: N: 38° 38.012' W: 76° 22.429'	DEPTH WATER ENC.:	AT END DRILL:	AT 24 HRS:	CAVED DEPTH:
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL: 30.0"	TYPE OF CORE:	DEPTH OF BORING: 28.6
TYPE OF DRILL RIG & METHOD: HSA	DEPTH TO ROCK:	LOGGED BY: C. Jacobs		PAGE NO. 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 11.0' @ 10:00 a.m.
5	-5								
10	-10								
			Medium gray and orange brown, very moist, Silty CLAY, little fine Sand, trace Shell fragments (CL)	S-1	24"	WOR/24"	DS	12"	
				S-2	24"	1- 1- 2- 3	DS	20"	
15	-15								
			Medium gray and orange brown, moist, Clayey fine to medium SAND (SC)	S-3	24"	3-4-6-10	DS	20"	
			Yellowish brown, fine to medium SAND and GRAVEL (SM)	S-4	24"	6-10-4-4	DS	3"	
20	-20		Light greenish gray, Silty fine to medium SAND, trace Clay and Shell fragments (SM)						
				S-5	18"	4- 6- 9	DS	18"	
25	-25								
			Brownish gray, fine to medium SAND and Shell fragments	S-6	1"	50/1"	DS	1"	Auger Refusal @ 28.6 feet on angular Gravel
			Bottom of Boring @ 28.6 feet						
30	-30								
35	-35								

E2CR, INC.

BORING LOG

PROJECT			PROJECT NO.	BORING NO.
Sharps Island			01583-04	S - 26
SITE Chesapeake Bay, Maryland	**BEGUN** 01/28/02	**COMPLETED** 01/28/02	**HOLE SIZE**	**GROUND ELEVATION** 0.0
COORDINATES N: 38° 36.655' W: 76° 22.824'	**DEPTH WATER ENC.**	**AT END DRILL**	**AT 24 HRS**	**CAVED DEPTH**
DRILLER J. Sies	**WEIGHT OF HAMMER** 140 lbs.	**HEIGHT OF FALL** 30.0"	**TYPE OF CORE**	**DEPTH OF BORING** 38
TYPE OF DRILL RIG & METHOD HSA	**DEPTH TO ROCK**	**LOGGED BY:** C. Jacobs		**PAGE NO.** 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 12.0'
5	-5								
10	-10								
			Medium gray and orange brown, moist, Silty CLAY, trace to little fine Sand (with layers of Clayey Sand) (CL)	S-1	24"	2- 2- 3- 3	DS	17"	
15	-15			S-2	24"	2- 2- 2- 2	DS	22"	
				S-3	24"	WOH/24"	DS	24"	
20	-20		Medium gray, very moist, Silty CLAY, trace to little fine Sand (CL)	S-4	24"	WOH/24"	DS	18"	
				VS-1	6"	Vane Shear	VS	-	
25	-25			ST-1	24"	Pushed Tube	ST	16"	
			Greenish gray, moist, Silty CLAY, little fine Sand, trace Shell fragments (CL)	VS-2	6"	Vane Shear	VS	-	
30	-30			S-5	18"	1- 1- 1	DS	18"	
35	-35			S-6	18"	1- 1- 1	DS	8"	

E2CR, Inc.	BORING LOG	BORING NO. S - 26
PROJECT Sharps Island	PROJECT NO. 01583-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Medium gray, wet, fine SAND and GRAVEL, trace Silt (SP-GP)	S-7	6"	50/0.5"	DS	.50"	Auger Refusal @ 38.0 feet
			Bottom of Boring @ 38.0 feet						
40	-40								
45	-45								
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT Sharps Island			PROJECT NO. 01583-04		BORING NO. S - 27
SITE Chesapeake Bay, Maryland	BEGUN 01/28/02	COMPLETED 01/28/02	HOLE SIZE		GROUND ELEVATION 0.0
COORDINATES N: 38° 36.908' W: 76° 21.360'	DEPTH WATER ENC.	AT END DRILL	AT 24 HRS		CAVED DEPTH
DRILLER J. Sies	WEIGHT OF HAMMER 140 lbs.	HEIGHT OF FALL 30.0"	TYPE OF CORE		DEPTH OF BORING 40
TYPE OF DRILL RIG & METHOD HSA	DEPTH TO ROCK	LOGGED BY: C. Jacobs			PAGE NO. 1 OF 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA					REMARKS:
				SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	
0	0		Water						Water depth 9.0' @ 8:00 a.m.
5	-5								
10	-10		Brownish gray, wet, Clayey fine to medium SAND (SC)	S-1	24"	WOR/12"- 1-1	DS	22"	
				S-2	24"	1- 3- 3- 3	DS	23"	
15	-15		Brownish gray, fine to medium SAND, trace Silt (SP-SM)						
				S-3	24"	1- 1- 1- 3	DS	3"	
				S-4	24"	2- 2- 3- 3	DS	18"	
20	-20								
			Greenish gray, very moist to moist, Silty CLAY (CL-CH)						
25	-25			S-5	18"	2- 3- 3	dS	18"	
				S-6	18"	WOR/18"	DS	18"	
30	-30								
35	-35			S-7	18"	WOR/18"	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. S - 27	
PROJECT Sharps Island		PROJECT NO. 01583-04	PAGE 2 OF 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray, very moist to moist, Silty CLAY (CL-CH)	S-8	18"	WOR/18"	DS	18"	
40	-40		Bottom of Boring @ 40.0 feet						
45	-45								
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

APPENDIX-D

LABORATORY TEST RESULTS

[redacted]

E2C/R inc.

CONSTRUCTION · REMEDIATION

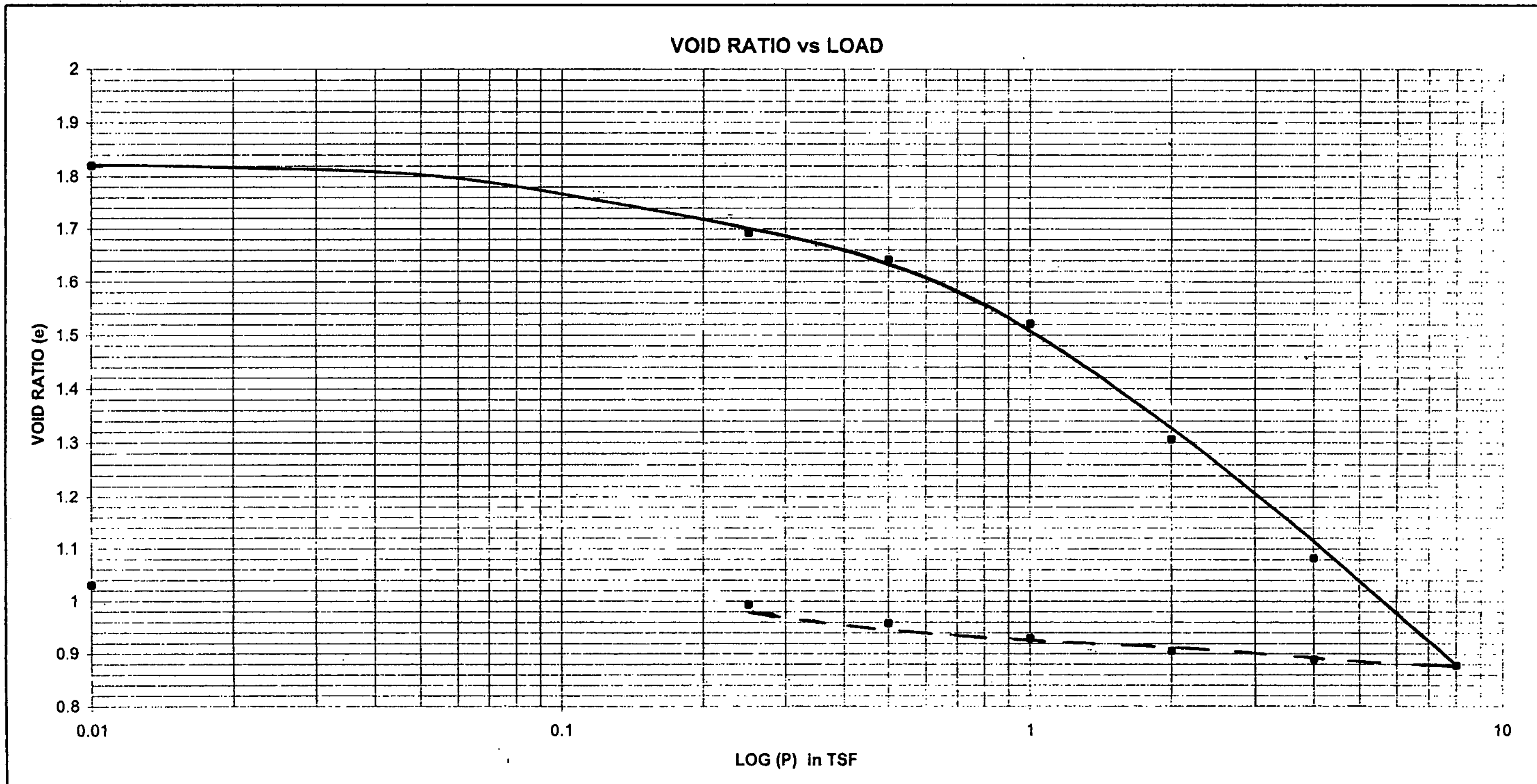
CONSOLIDATION TEST

PROJECT NAME: Sharps Island PROJECT NO: 01583-04

SAMPLE NUMBER: S-2 DEPTH (FT): 44.5-46.5 MOISTURE CONTENT: 67.2 % LAB NO:

WET DENSITY (pcf): 98.7 DRY DENSITY (pcf): 59.0 SPECIFIC GRAVITY: 2.67 INITIAL VOID RATIO: 1.82

SOIL DESCRIPTION: Brownish Green, Silty CLAY



[redacted]ENGIN[redacted] · [redacted]ULTAT[redacted]
E/2C/R inc.
CONSTRUCTION · REMEDIATION ·

CONSOLIDATION TEST

PROJECT NAME: Sharps Island

PROJECT NO: 01583-04

SAMPLE NUMBER: S-4

DEPTH (FT): 30.0'-32.0'

MOISTURE CONTENT: 66.8 %

LAB NO:

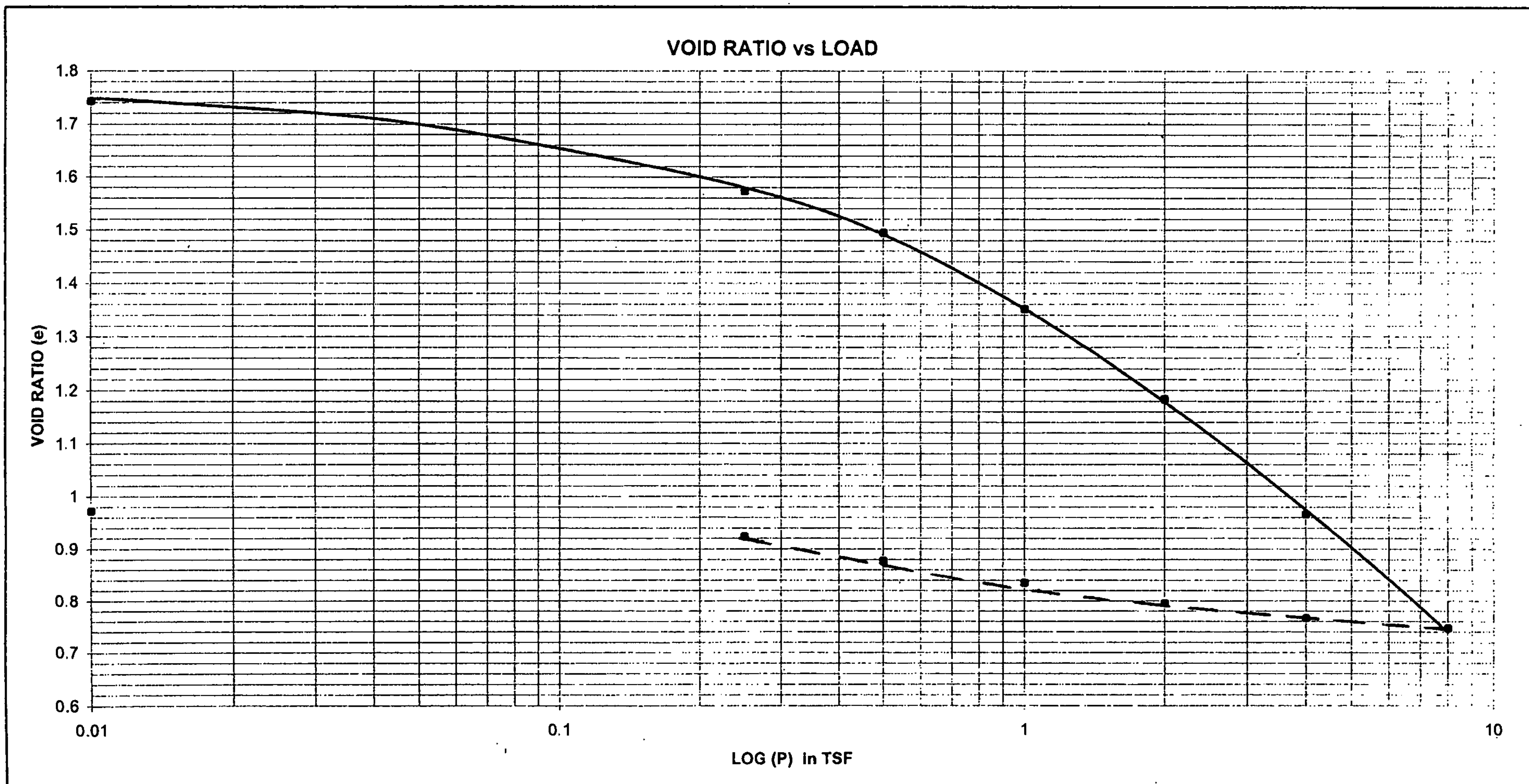
WET DENSITY (pcf): 101.2

DRY DENSITY (pcf): 60.7

SPECIFIC GRAVITY: 2.67

INITIAL VOID RATIO: 1.74

SOIL DESCRIPTION: Greenish Gray, Silty CLAY



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CONSTRUCTION · REMEDIATION ·

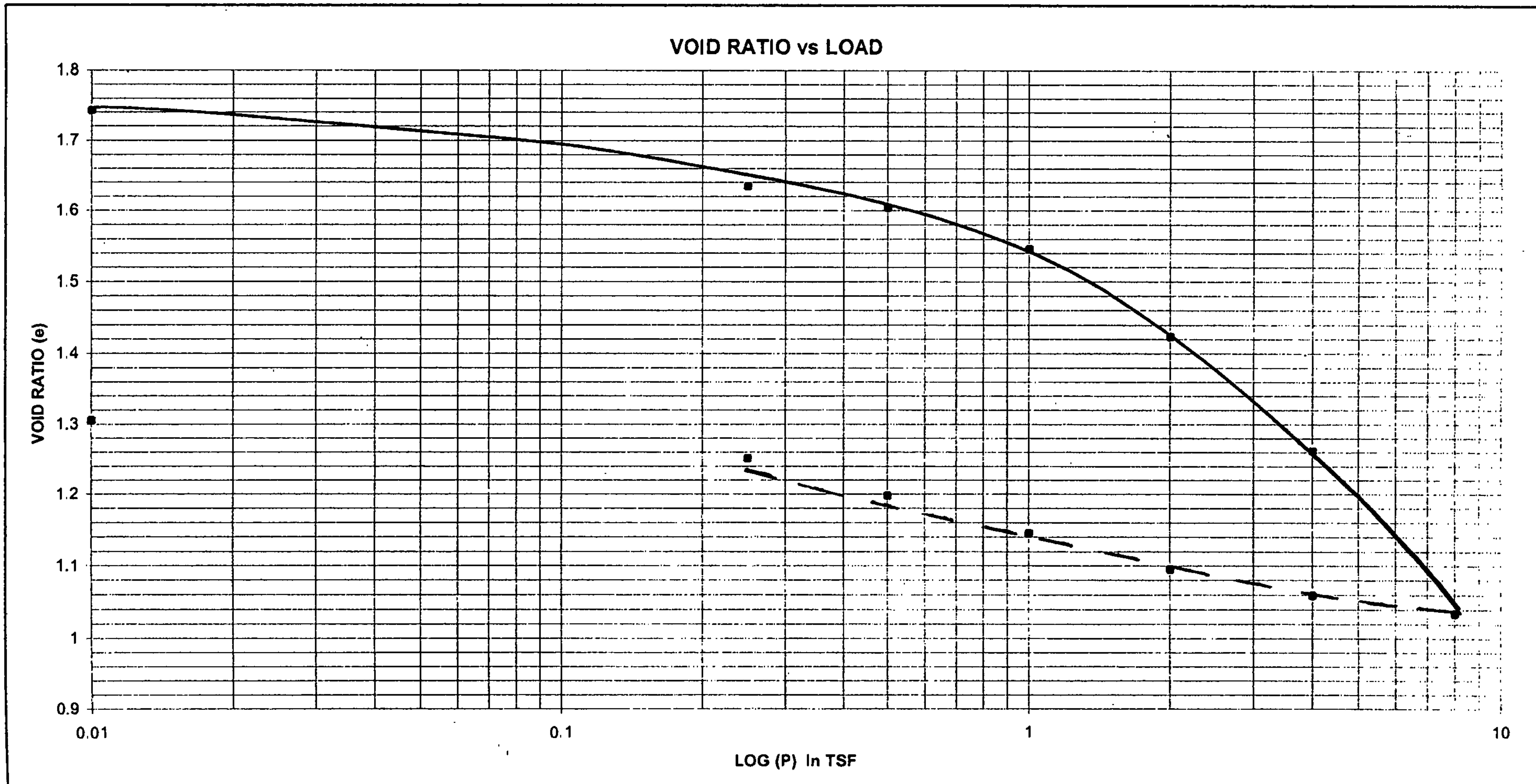
CONSOLIDATION TEST

PROJECT NAME: Sharps Island | PROJECT NO: 01583-04

SAMPLE NUMBER: S-17A | DEPTH (FT): 25.0'-27.0' | MOISTURE CONTENT: 53.6 % | LAB NO:

WET DENSITY (pcf): 104.2 | DRY DENSITY (pcf): 67.8 | SPECIFIC GRAVITY: 2.67 | INITIAL VOID RATIO: 1.74

SOIL DESCRIPTION: Greenish Gray, Silty CLAY



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E/2/C/R inc.

CONSTRUCTION · REMEDIATION ·

CONSOLIDATION TEST

PROJECT NAME: Sharps Island

PROJECT NO: 01583-04

SAMPLE NUMBER: S-19

DEPTH (FT): 18.0'-20.0'

MOISTURE CONTENT: 40.0 %

LAB NO:

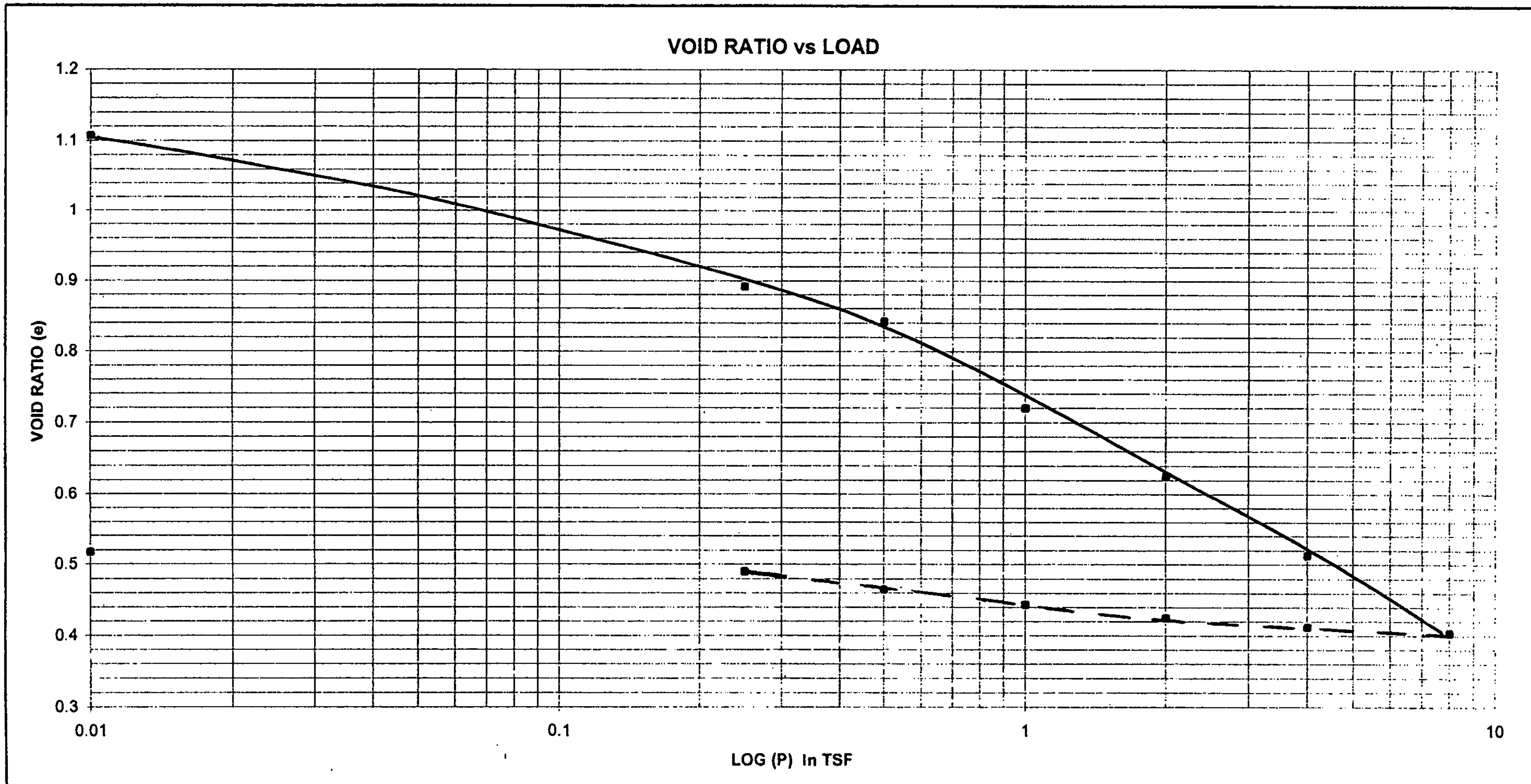
WET DENSITY (pcf): 110.6

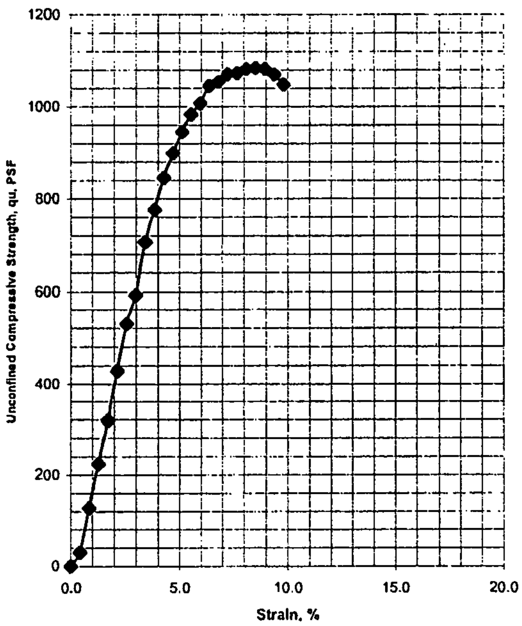
DRY DENSITY (pcf): 79.0

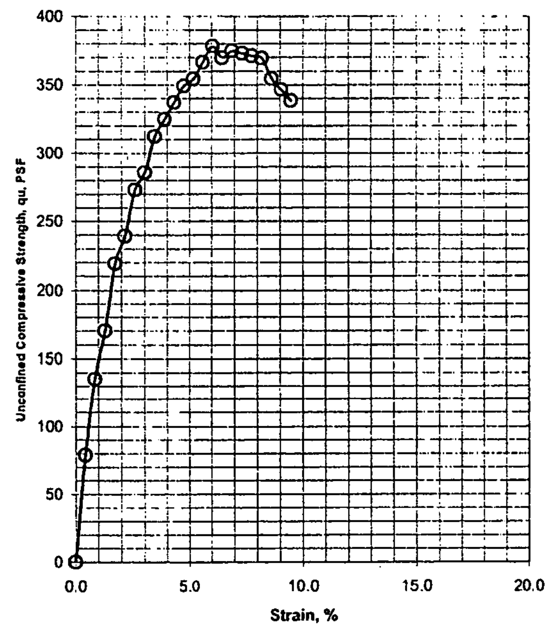
SPECIFIC GRAVITY: 2.67

INITIAL VOID RATIO: 1.11

SOIL DESCRIPTION: Greenish Gray,Silty CLAY, trace to little F.Sand,trace Shell







Boring No.	S-2		Boring No.	S-4	
Depth	44.5'-46.5'	FEET	Depth	30.0'-32.0'	FEET
Diameter, D	2.8	INCH	Diameter, D	2.9	INCH
Length, L	5.9	INCH	Length, L	5.8	INCH
L/D Ratio	2.1		L/D Ratio	2.0	
q_u	1084	PSF	q_u	378	PSF
W.C.	57.8	%	W.C.	66.7	%
Dry density	64.7	PCF	Dry density	57.7	PCF
Void Ratio			Void Ratio		
q_{ur}		PSF	q_{ur}		PSF
Sensitivity			Sensitivity		
Liquid Limit	73	%	Liquid Limit	82	%
Plasticity Index	36	%	Plasticity Index	46	%
Description:			Description:		
Brownish Gray, Clayey SILT			Greenish Gray,Silty CLAY,trace Sand		

Sketch at Failure:

Sketch at Failure:

Project Name:	Sharps Island	Date:	2/8/02
Project No.:	01583-04	Figure:	

UNCONFINED COMPRESSION

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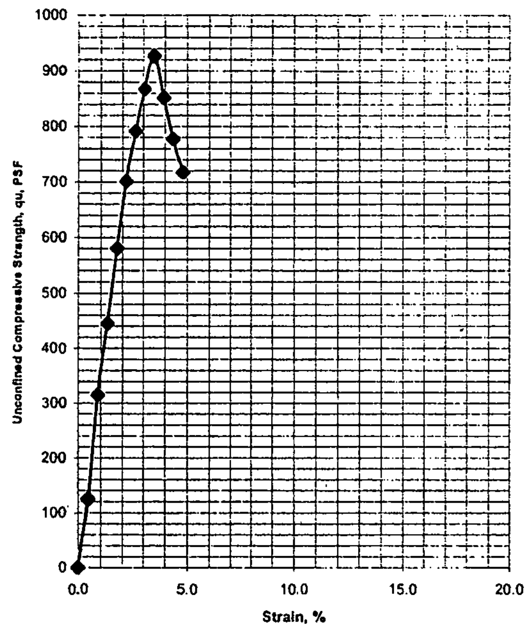
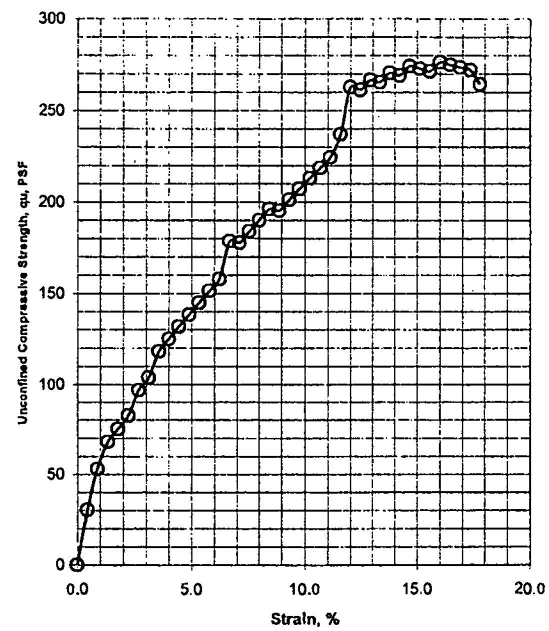




	S-17A			S-19	
Boring No.	S-17A		Boring No.	S-19	
Depth	25.0'-27.0'	FEET	Depth	18.0'-20.0'	FEET
Diameter, D	2.9	INCH	Diameter, D	2.8	INCH
Length, L	5.7	INCH	Length, L	5.6	INCH
L/D Ratio	2.0		L/D Ratio	2.0	
q_u	927	PSF	q_u	276	PSF
W.C.	48.9	%	W.C.	41.9	%
Dry density	72.1	PCF	Dry density	84.1	PCF
Void Ratio			Void Ratio		
q_{ur}		PSF	q_{ur}		PSF
Sensitivity			Sensitivity		
Liquid Limit	73	%	Liquid Limit	50	%
Plasticity Index	38	%	Plasticity Index	23	%
Description: Greenish Gray, Silty CLAY			Description: Greenish Gray, Silty CLAY		

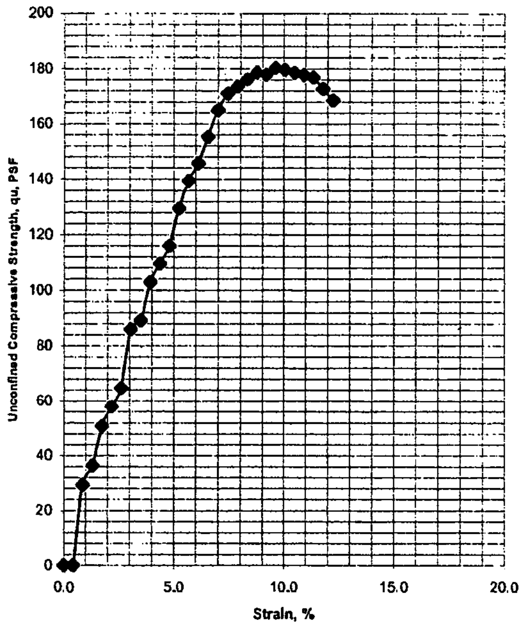
Sketch at Failure:

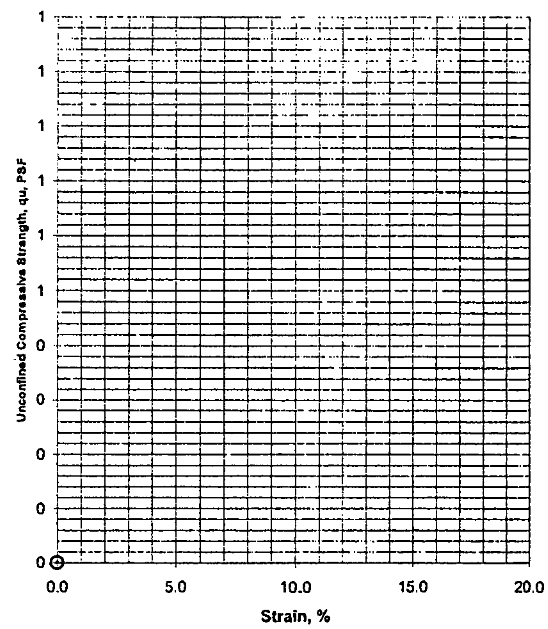
Sketch at Failure:

Project Name:	Sharps Island	Date:	2/12/02
Project No.:	01583-04	Figure:	

UNCONFINED COMPRESSION

ENGINEERING · CONSULTATION · E2CR inc. CONSTRUCTION · REMEDIATION ·





Boring No.	S-26		Boring No.		
Depth	24.5'-26.5'	FEET	Depth		FEET
Diameter, D	2.9	INCH	Diameter, D		INCH
Length, L	5.7	INCH	Length, L		INCH
L/D Ratio	2.0		L/D Ratio		
q_u	180	PSF	q_u		PSF
W.C.	45.5	%	W.C.		%
Dry density	74.0	PCF	Dry density		PCF
Void Ratio			Void Ratio		
q_{ur}		PSF	q_{ur}		PSF
Sensitivity			Sensitivity		
Liquid Limit	47	%	Liquid Limit		%
Plasticity Index	24	%	Plasticity Index		%
Description:			Description:		
Greenish Gray, Silty CLAY little F.Sand					

Sketch at Failure:

Sketch at Failure:

Project Name:	Sharps Island	Date:	2/12/02
Project No.:	01583-04	Figure:	

UNCONFINED COMPRESSION

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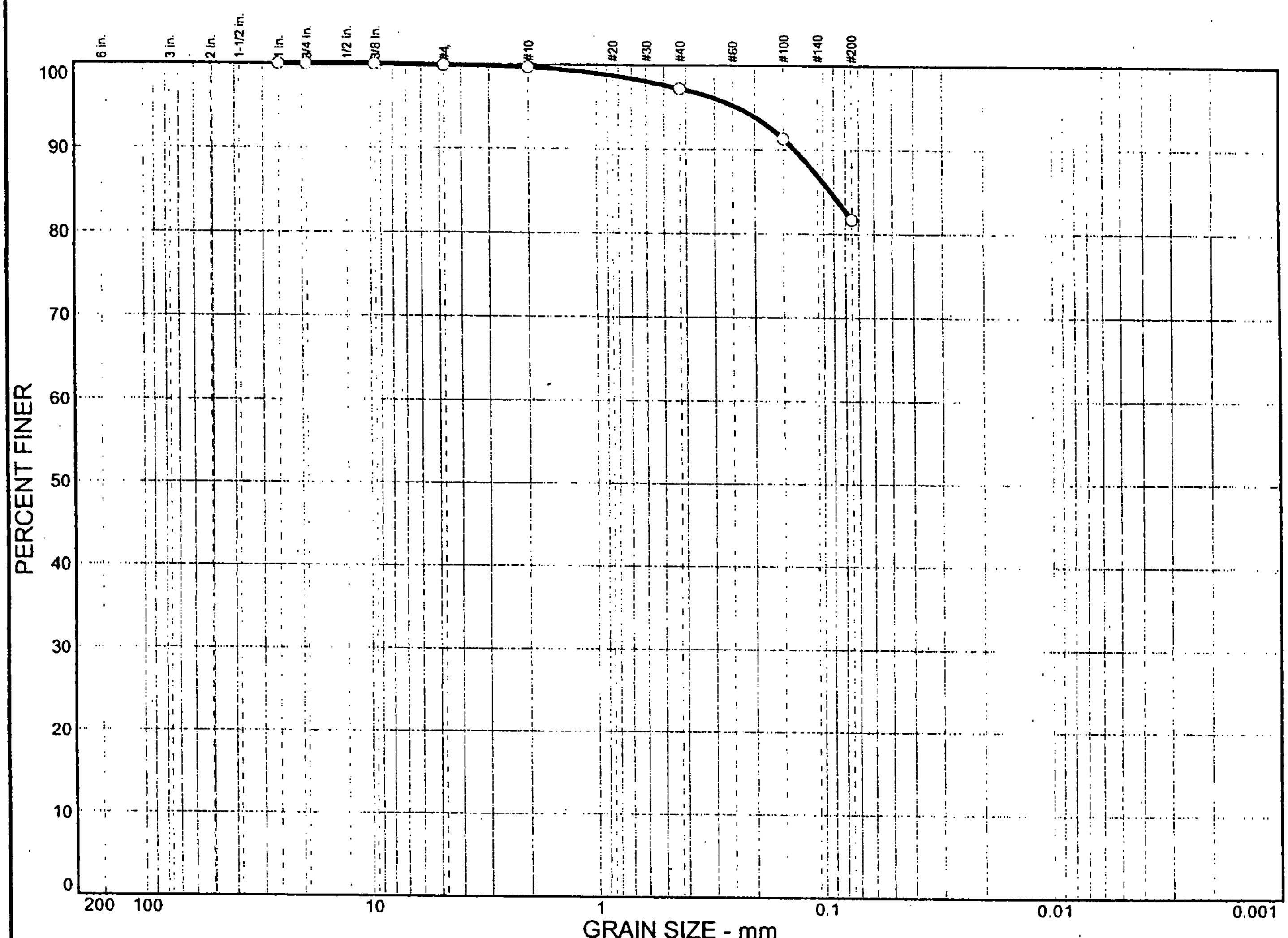
Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.1	18.2	81.7	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0931							

MATERIAL DESCRIPTION	USCS	AASHTO
○ Orange Brown & Gray, Silty CLAY, little Fine Sand	CL	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers

Project: Sharps Island

○ **Source:** S-1 **Sample No.:** S-2 **Elev./Depth:** 11.0'-13.0'

Remarks:

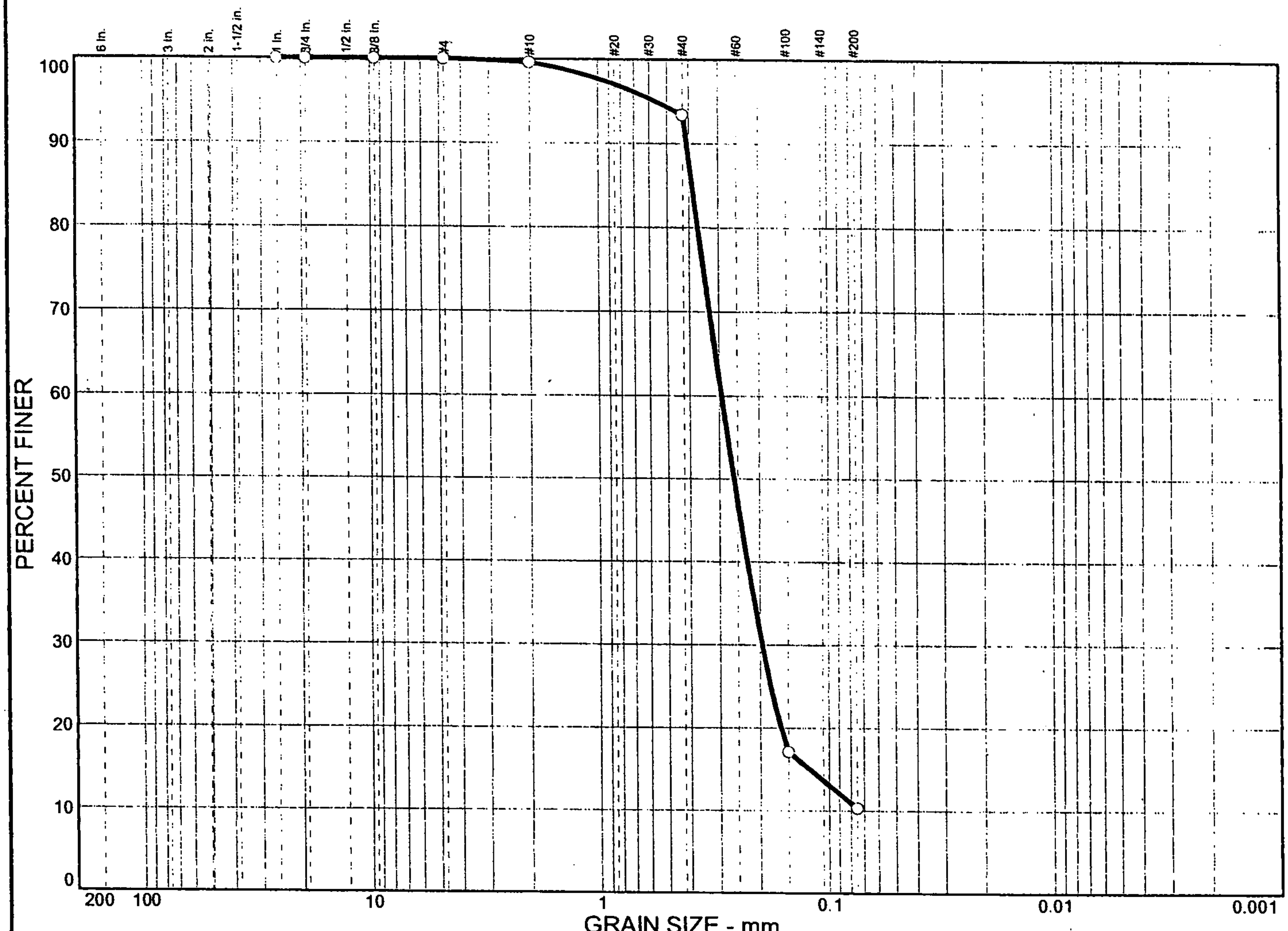
○Natural Moisture = 25.7 %

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	89.7	10.3	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.388	0.293	0.259	0.195	0.121			

MATERIAL DESCRIPTION	USCS	AASHTO
○ Orange Brown, Fine to Medium SAND, little Silt	SP-SM	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers

Project: Sharps Island

○ **Source:** S-1 **Sample No.:** S-4 **Elev./Depth:** 18.0'-20.0'

Remarks:

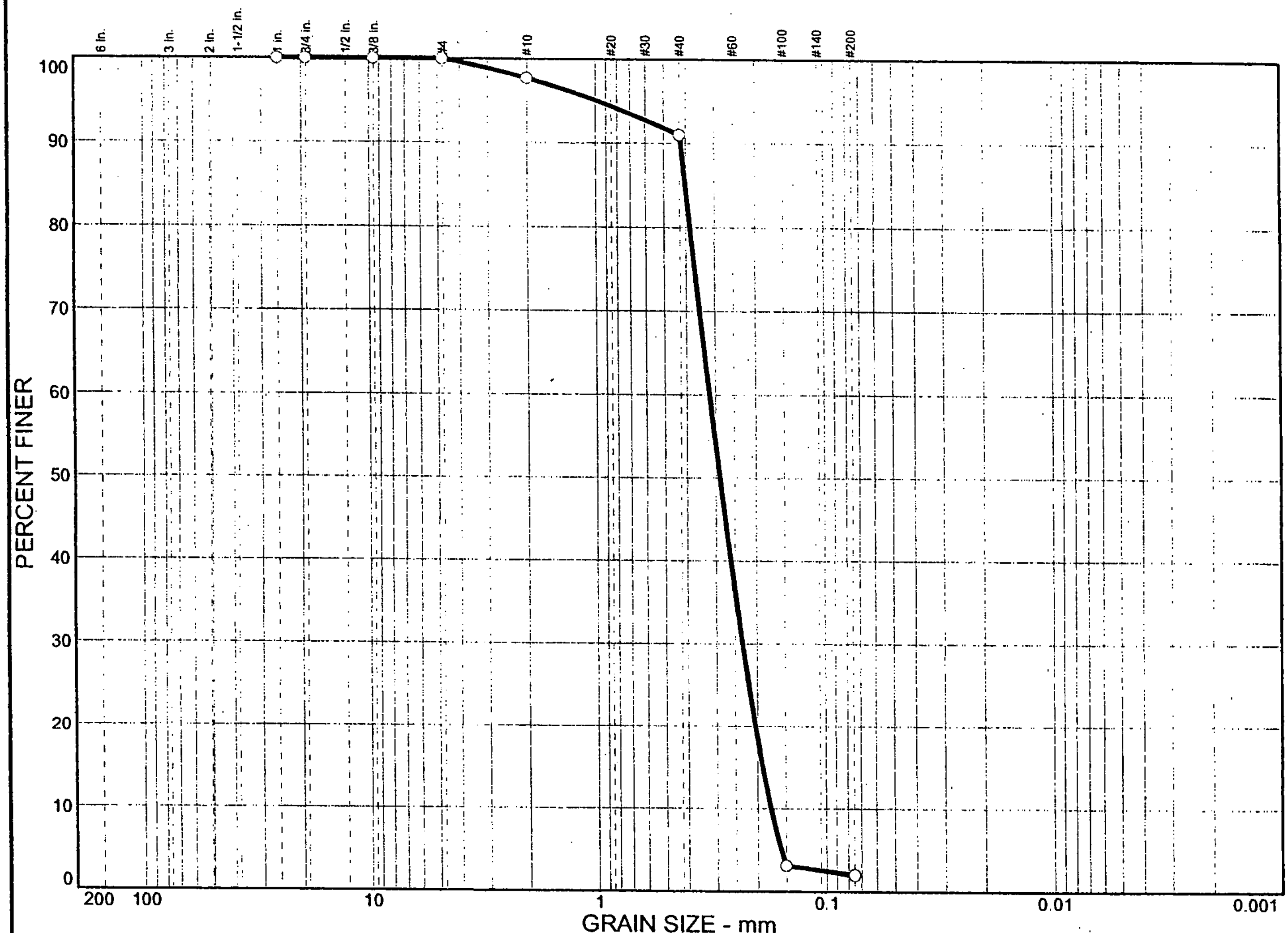
○ Natural Moisture = 22.7 %

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	98.0	2.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.402	0.318	0.288	0.232	0.190	0.175	0.97	1.82

MATERIAL DESCRIPTION	USCS	AASHTO
○ Gray, Fine to Medium SAND, trace Shell	SP	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers

Project: Sharps Island

○ **Source:** S-2 **Sample No.:** S-1 **Elev./Depth:** 10.0'-12.0'

Remarks:

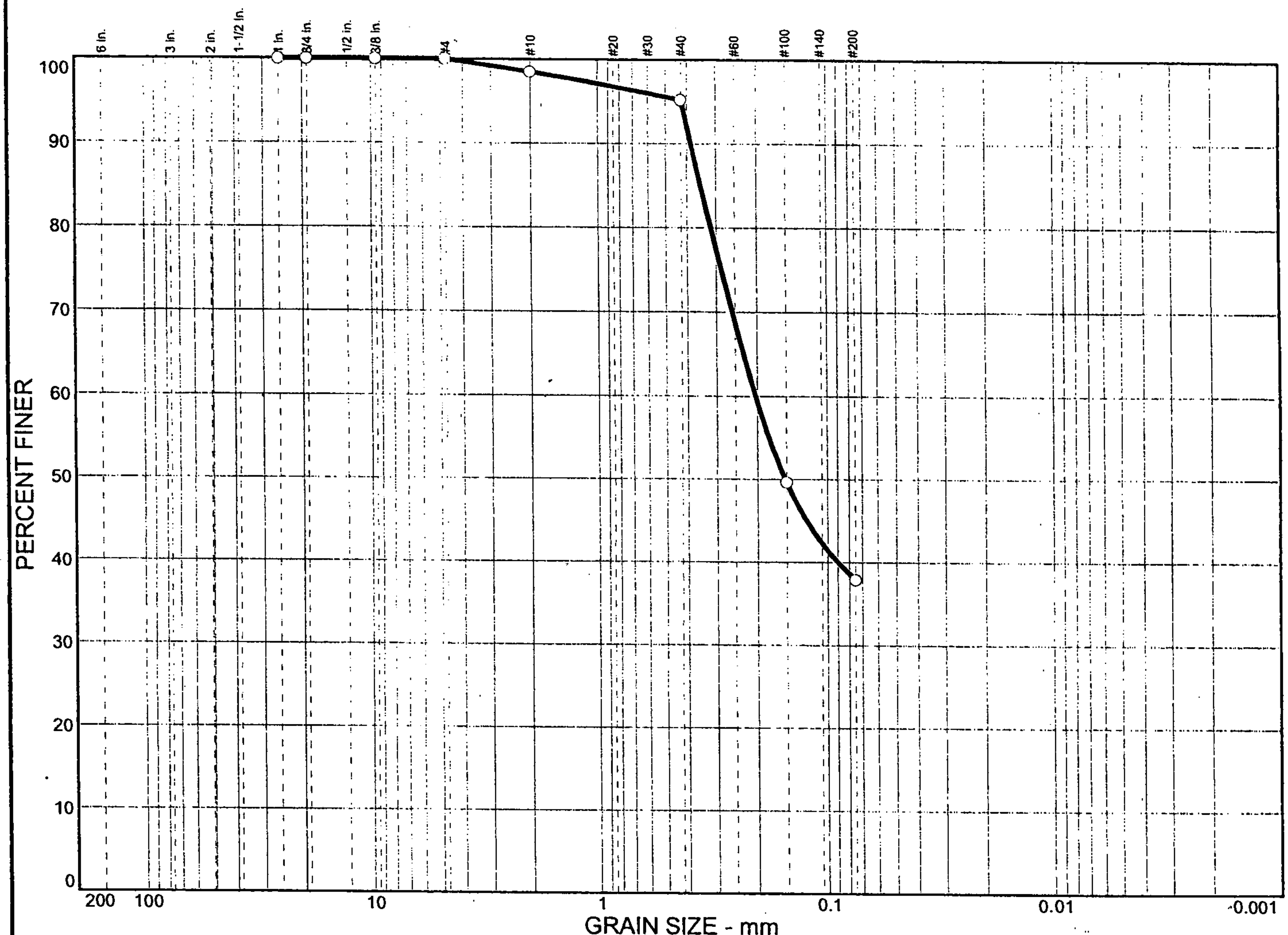
○ Natural Moisture = 30.2 %

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	62.1	37.9	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.349	0.204	0.152					

MATERIAL DESCRIPTION	USCS	AASHTO
○ Brownish Gray, Silty F-M SAND	SM	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers
Project: Sharps Island

○ **Source:** S-2 **Sample No.:** S-5 **Elev./Depth:** 23.5'-25.0'

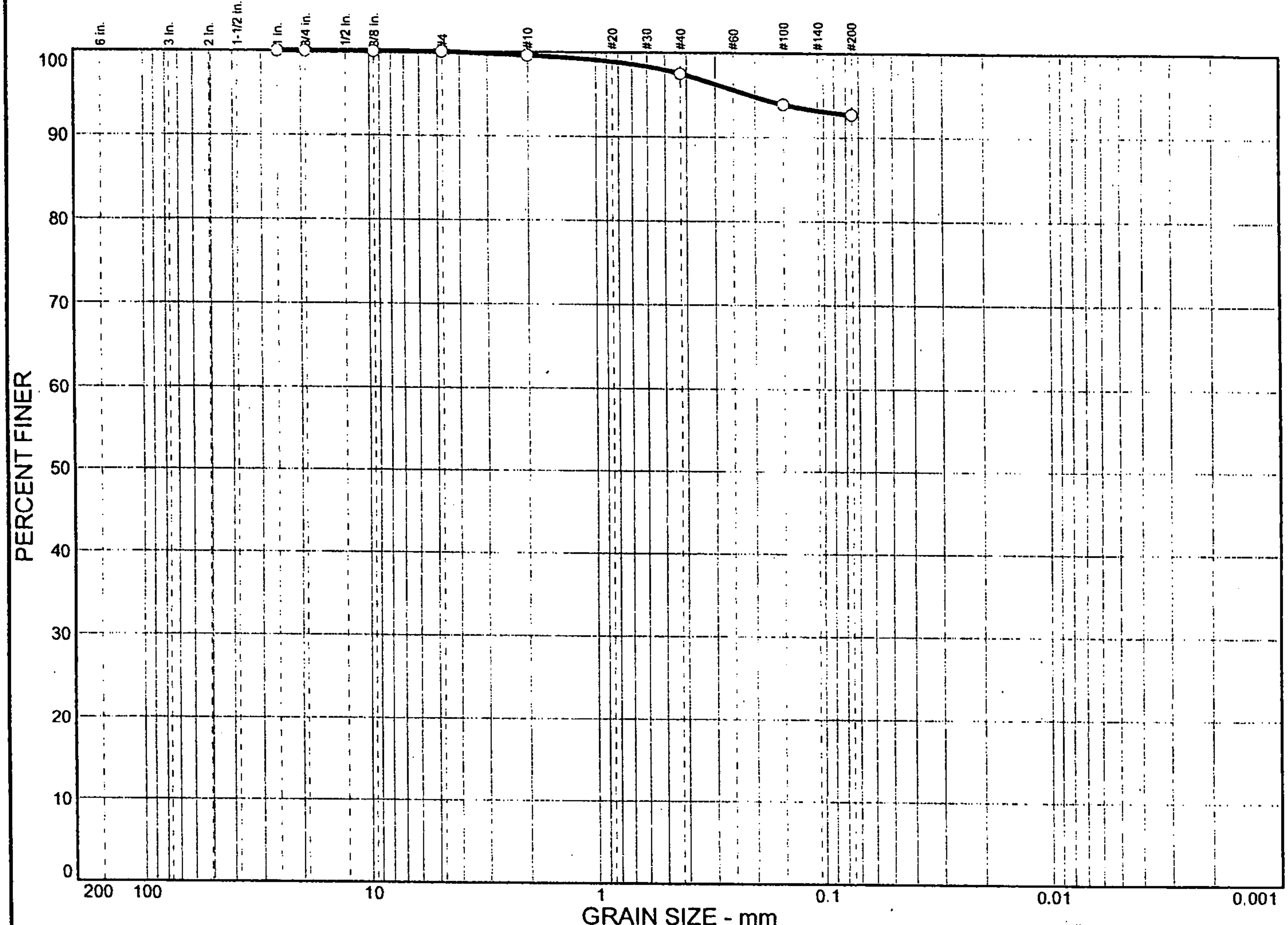
Remarks:
○ Natural Moisture = 37.5 %

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	7.3	92.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	103	58	0.115							

MATERIAL DESCRIPTION	USCS	AASHTO
○ Dark Brown, Clayey SILT, trace to little Organic	MH	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers
Project: Sharps Island

○ **Source:** S-6 **Sample No.:** S-3 **Elev./Depth:** 20.0'-22.0'

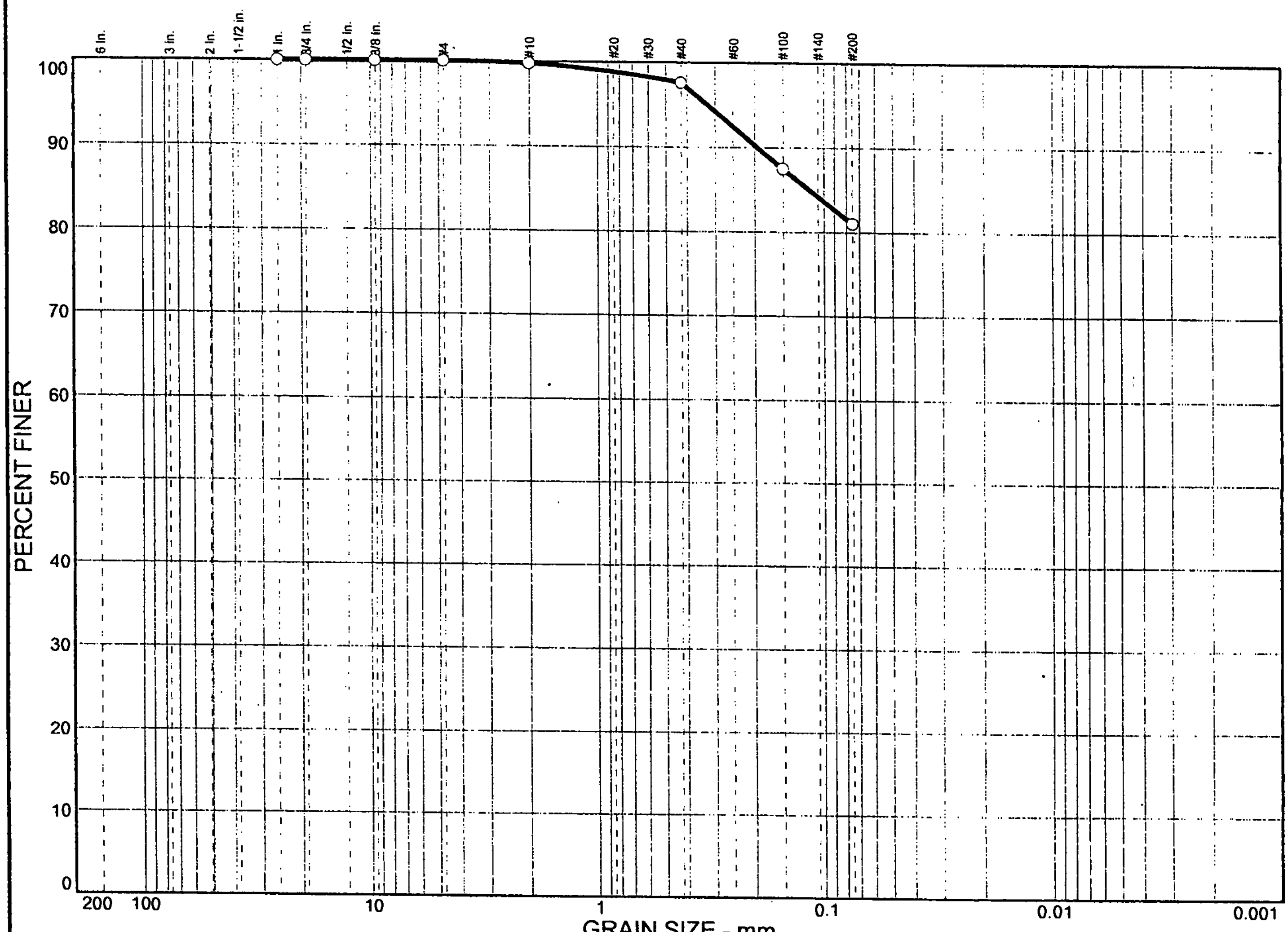
Remarks:
○ Natural Moisture = 59.5 %
Plasticity Index = 45

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	19.0	81.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	103	58	0.115							

MATERIAL DESCRIPTION	USCS	AASHTO
○ Dark Brown, Clayey SILT, trace to little Organic	MH	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers
Project: Sharps Island

○ **Source:** S-6 **Sample No.:** S-3 **Elev./Depth:** 20.0'-22.0'

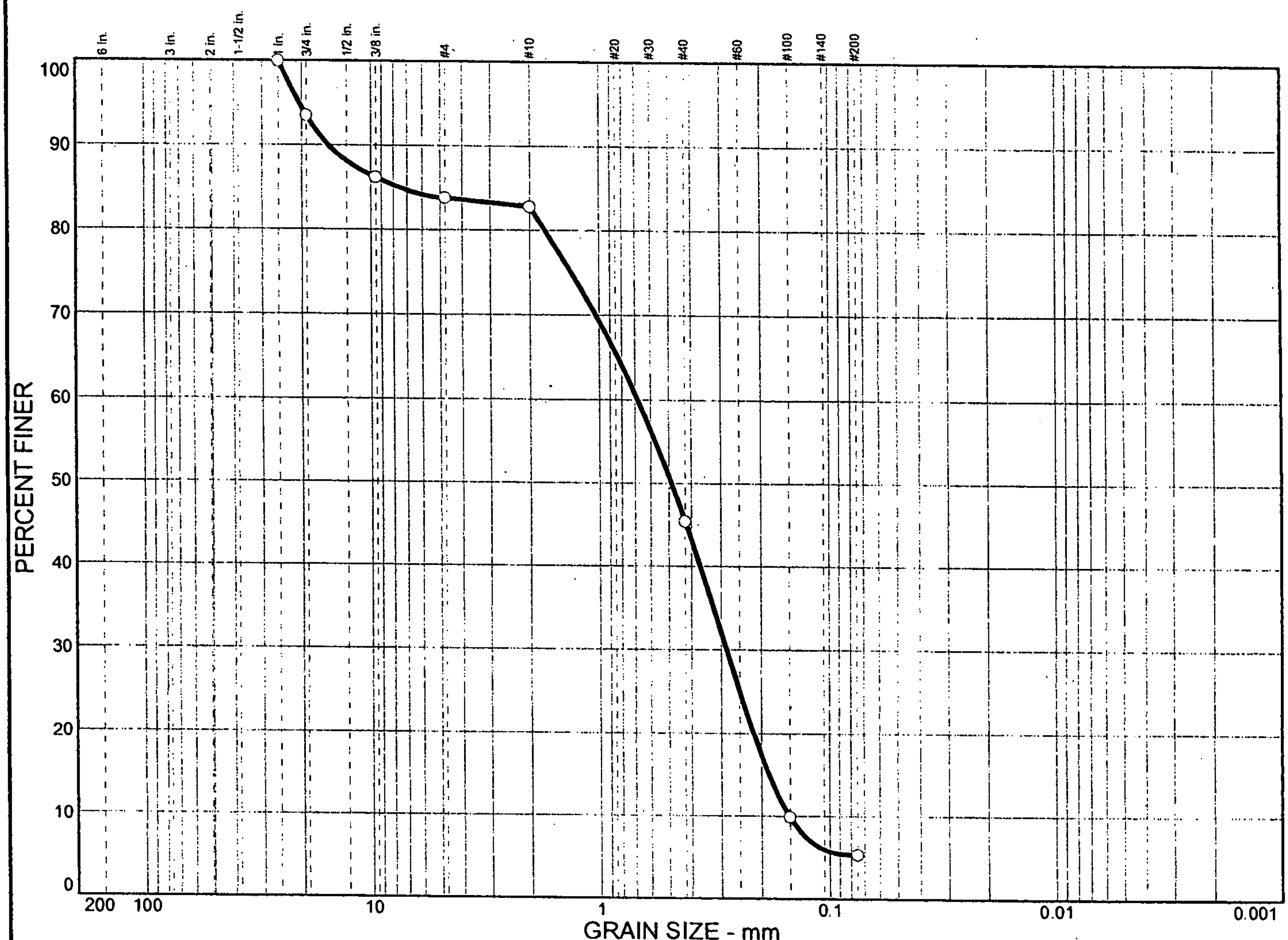
Remarks:
○ Natural Moisture = 59.5 %
Plasticity Index = 45

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	16.2	78.4	5.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			7.50	0.681	0.486	0.284	0.185	0.151	0.79	4.51

MATERIAL DESCRIPTION	USCS	AASHTO
○ Orange Brown, F-M SAND, little Gravel, trace Silt	SP-SM	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers

Project: Sharps Island

○ **Source:** S-7 **Sample No.:** S-3 **Elev./Depth:** 20.0'-22.0'

Remarks:

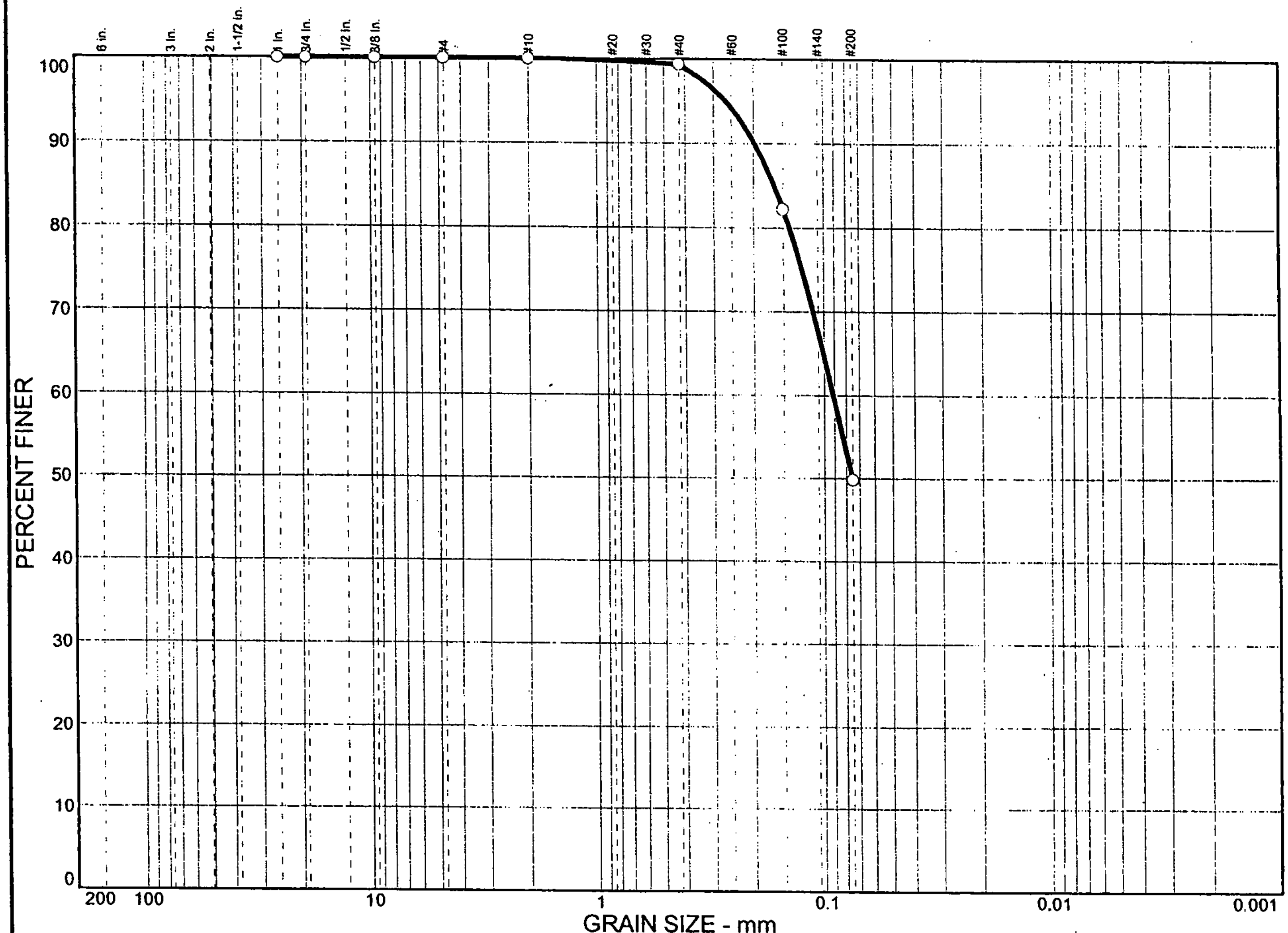
○ Natural Moisture = 15.1 %

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	50.2	49.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	61	35	0.163	0.0912	0.0753					

MATERIAL DESCRIPTION	USCS	AASHTO
○ Greenish Brown, Fine SAND and SILT, trace to little Clay, trace Shell & Organic	SM	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers
Project: Sharps Island

○ **Source:** S-10 **Sample No.:** S-6 **Elev./Depth:** 28.5'-30.0'

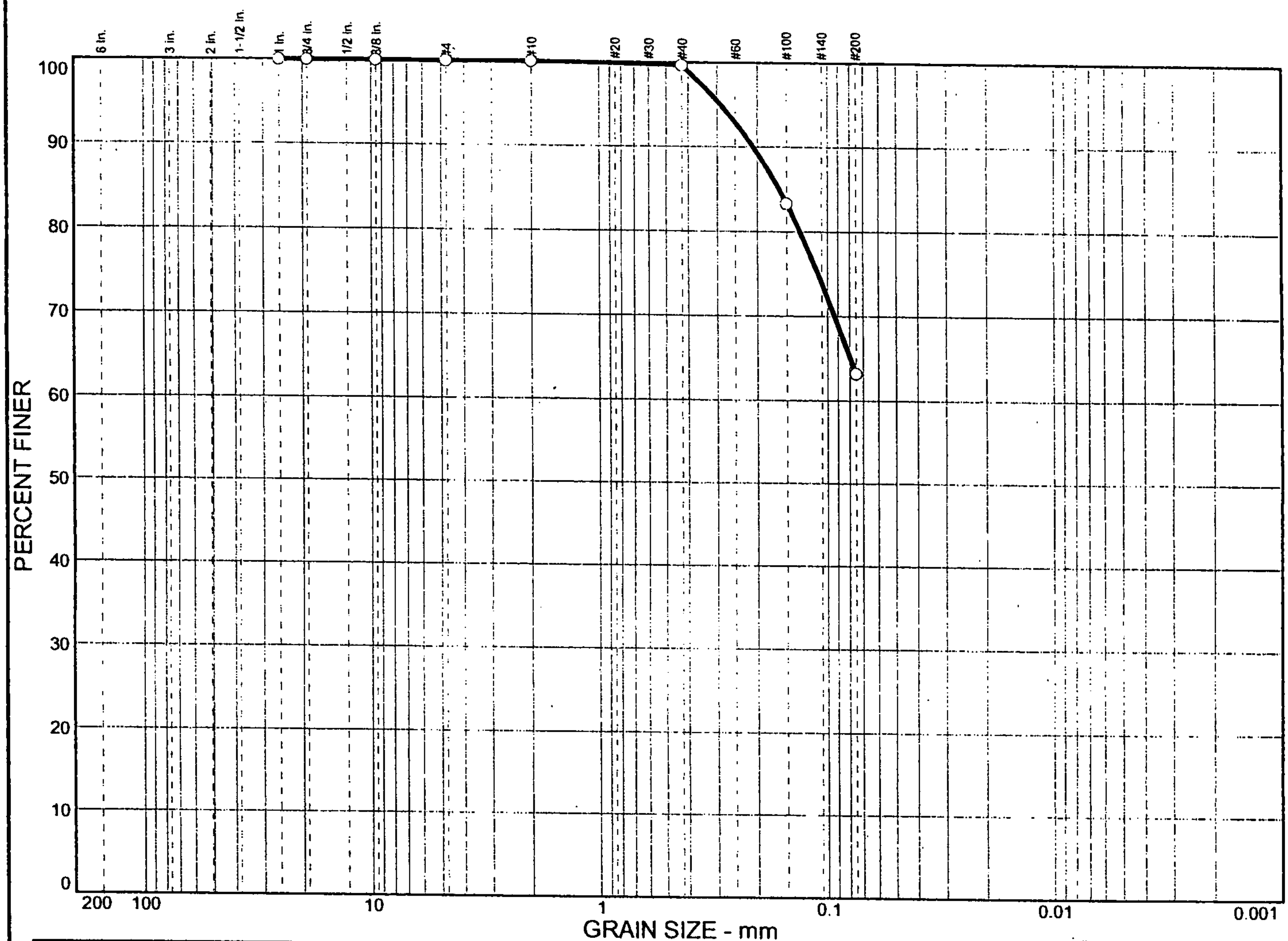
Remarks:
○ Natural Moisture = 42.8 %
Plasticity Index = 26

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	36.8	63.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	63	35	0.162							

MATERIAL DESCRIPTION	USCS	AASHTO
○ Greenish Gray, Clayey SILT, and Fine Sand	MH	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers

Project: Sharps Island

○ **Source:** S-11 **Sample No.:** S-5 **Elev./Depth:** 23.5'-25.0'

Remarks:

○ Natural Moisture = 49.2 %

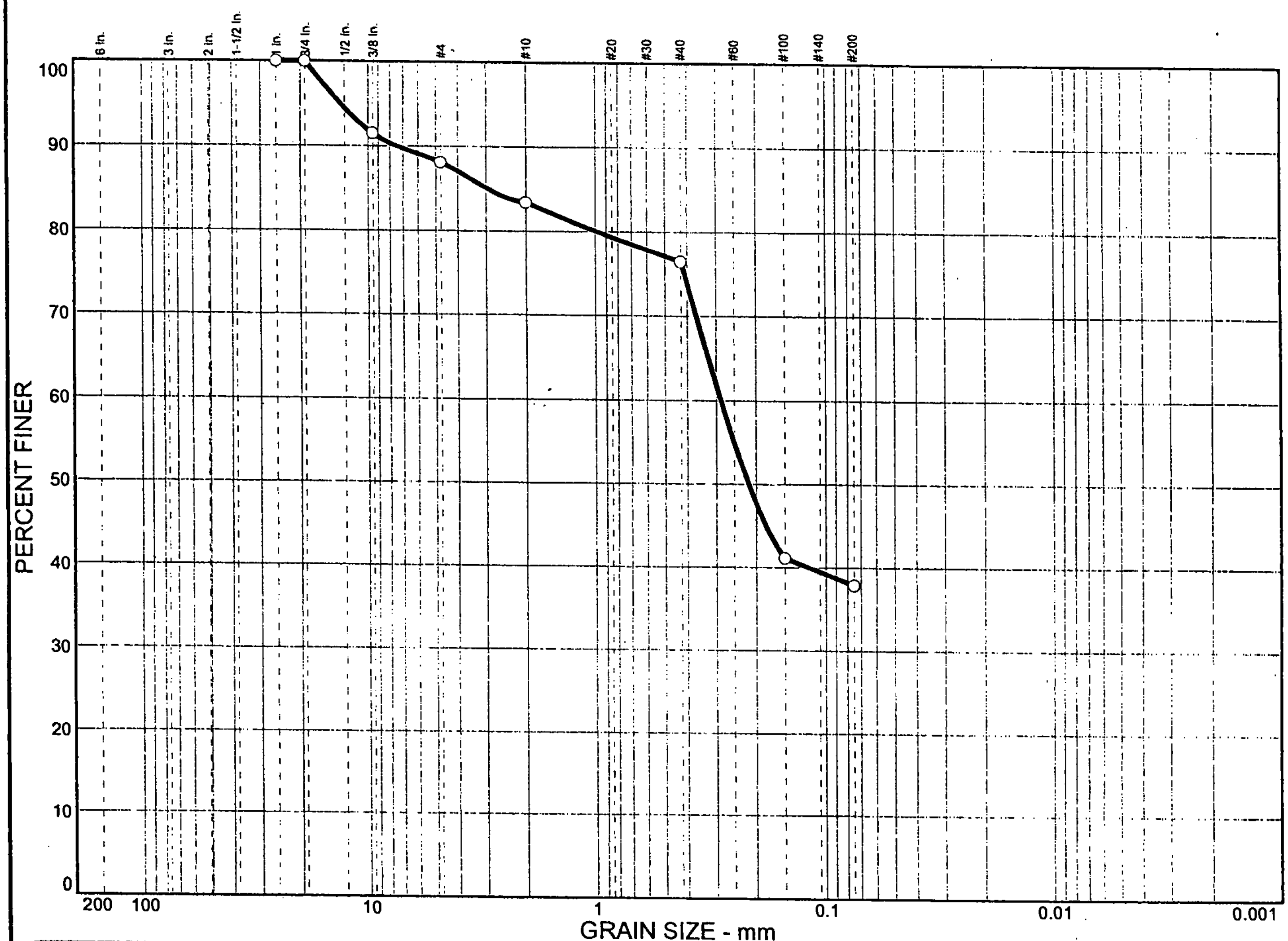
Plasticity Index = 28

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	11.9	50.2	37.9	

X	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			2.94	0.286	0.216					

MATERIAL DESCRIPTION	USCS	AASHTO
○ Gray & Orange Brown, Clayey F-C SAND, little Gravel	SC	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers
Project: Sharps Island

○ **Source:** S-16 **Sample No.:** S-2 **Elev./Depth:** 13.0'-15.0'

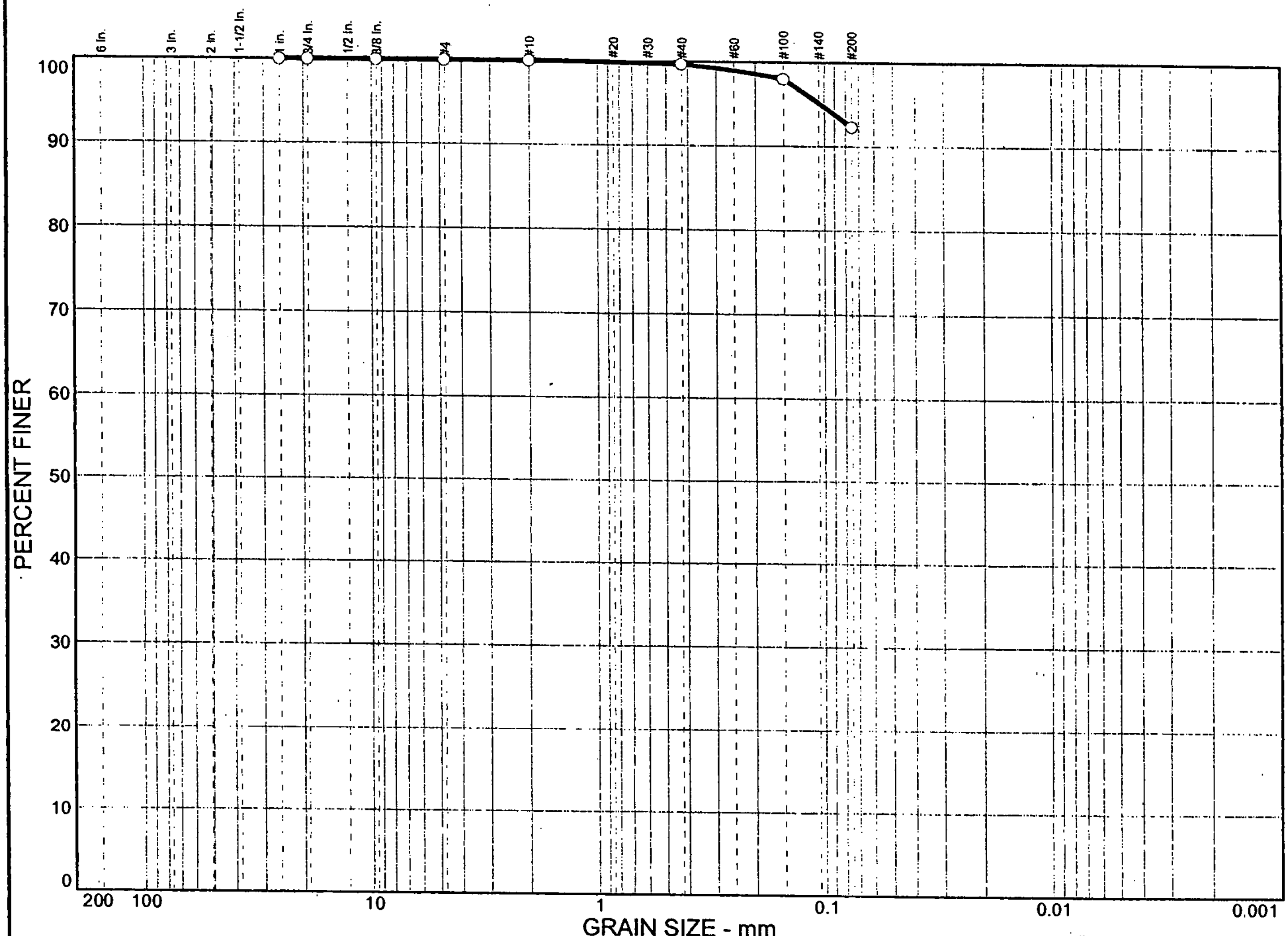
Remarks:
○ Natural Moisture = 27.8 %

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	7.7	92.3	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	73	37								

MATERIAL DESCRIPTION	USCS	AASHTO
○ Greenish Gray, Clayey SILT, trace Fine Sand	MH	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers
Project: Sharps Island

○ **Source:** S-16 **Sample No.:** S-6 **Elev./Depth:** 28.5'-30.0'

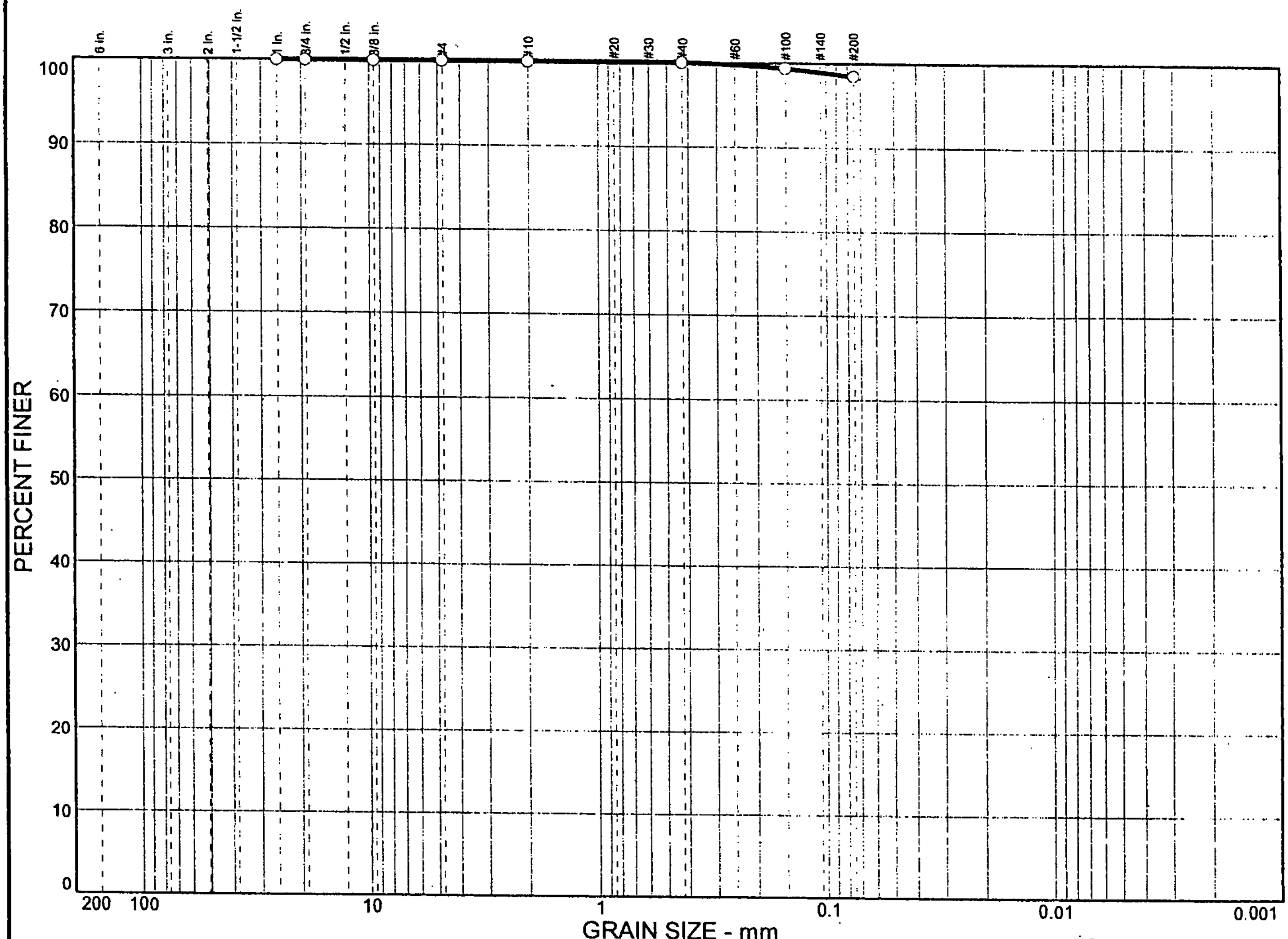
Remarks:
○ Natural Moisture = 56.3 %
Plasticity Index = 36

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	1.5	98.5	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	73	35								

MATERIAL DESCRIPTION	USCS	AASHTO
○ Greenish Gray, Clayey SILT	MH	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers

Project: Sharps Island

○ **Source:** S-17A **Sample No.:** ST1 **Elev./Depth:** 25.0'-27.0'

Remarks:

○ Natural Moisture = 53.6%

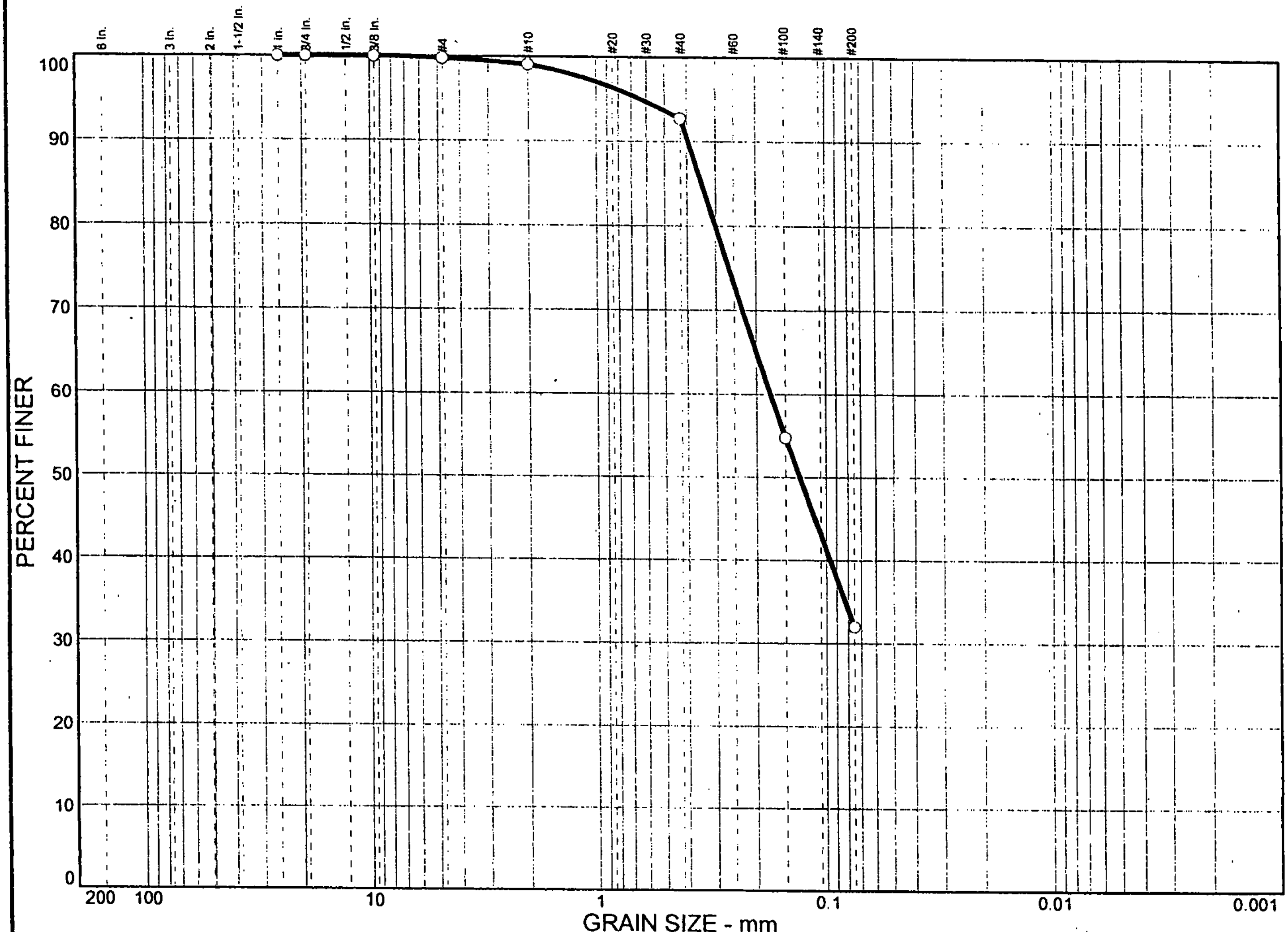
Plasticity Index = 38

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.2	67.8	32.0	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.345	0.174	0.130					

MATERIAL DESCRIPTION	USCS	AASHTO
○ Greenish Gray, Clayey F-M SAND, trace Shell	SC	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers
Project: Sharps Island

○ **Source:** S-18 **Sample No.:** S-3 **Elev./Depth:** 16.0'-18.0'

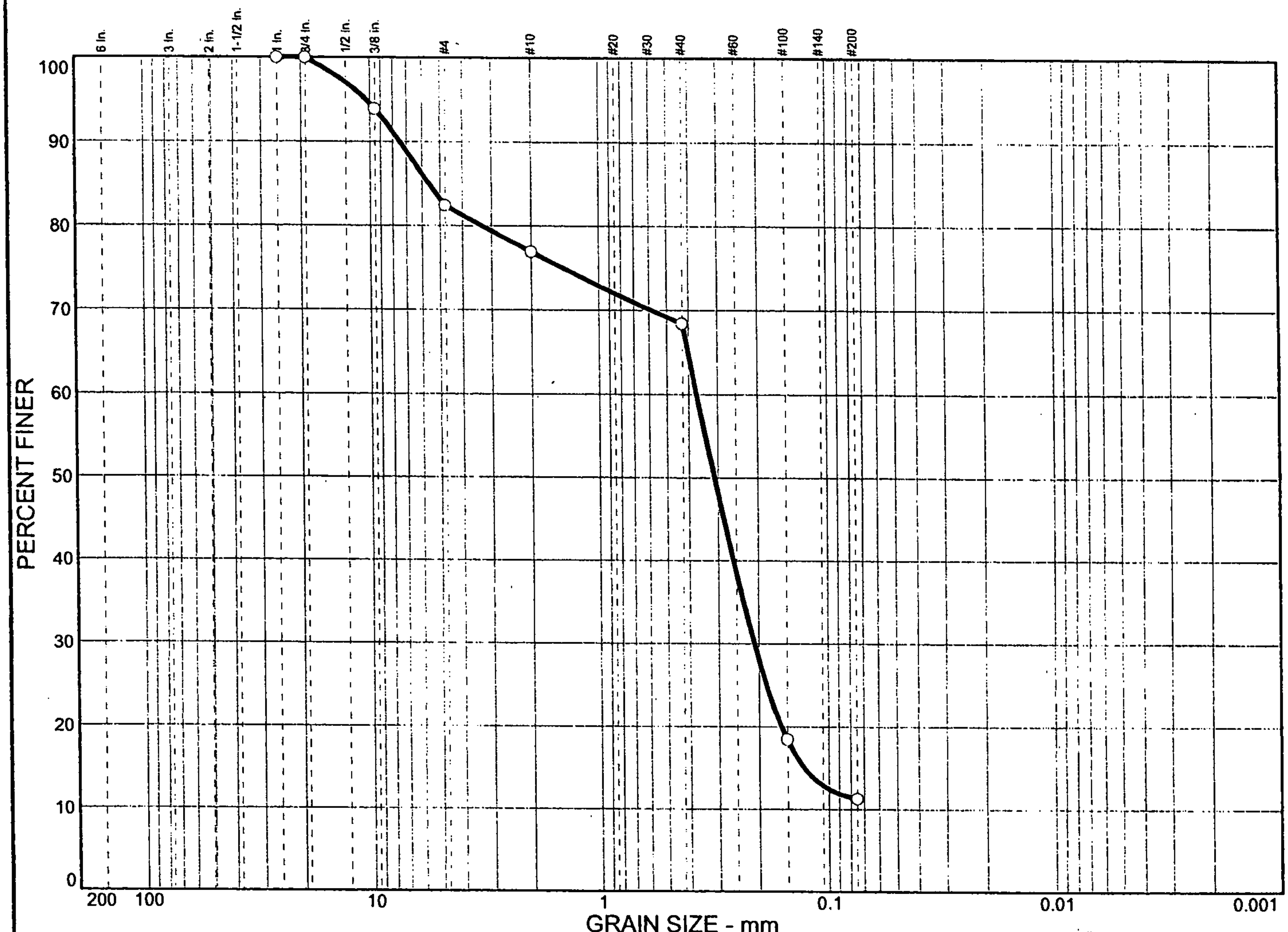
Remarks:
○ Natural Moisture = 32.4 %

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	17.6	71.1	11.3	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			5.59	0.369	0.310	0.209	0.127			

MATERIAL DESCRIPTION	USCS	AASHTO
○ Greenish Gray, Silty Fine SAND, trace to little Shells, trace Clay	SC-SM	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers
Project: Sharps Island

○ **Source:** S-18 **Sample No.:** S-5 **Elev./Depth:** 23.5'-25.0'

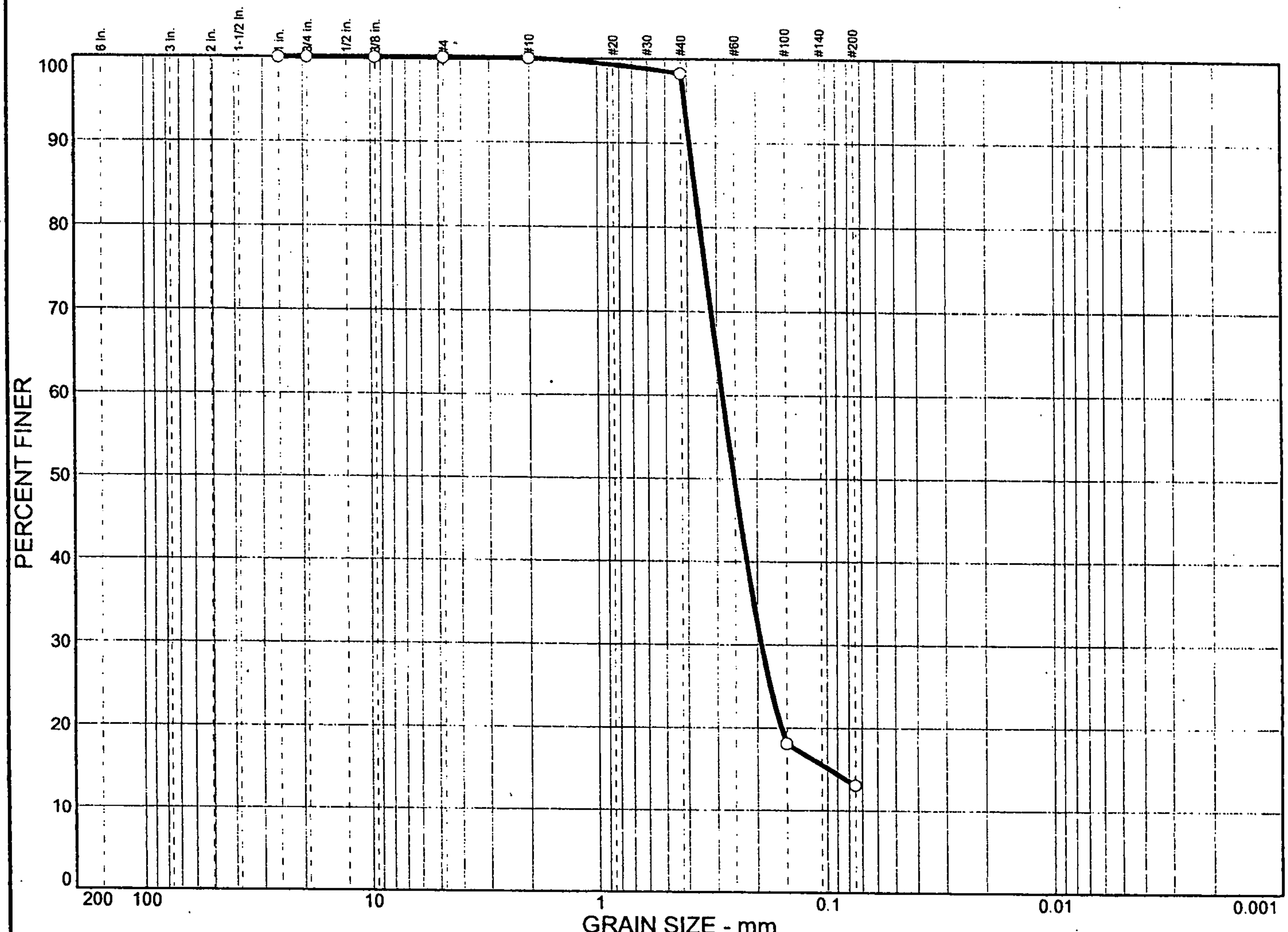
Remarks:
○ Natural Moisture = 23.0 %

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	86.9	13.1	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.371	0.284	0.253	0.192	0.0981			

MATERIAL DESCRIPTION	USCS	AASHTO
○ Orange Brown and Gray, Fine SAND, trace to little Clay, trace Shells	SM-SC	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers

Project: Sharps Island

○ **Source:** S-19 **Sample No.:** S-6 **Elev./Depth:** 28.5'-30.0'

Remarks:

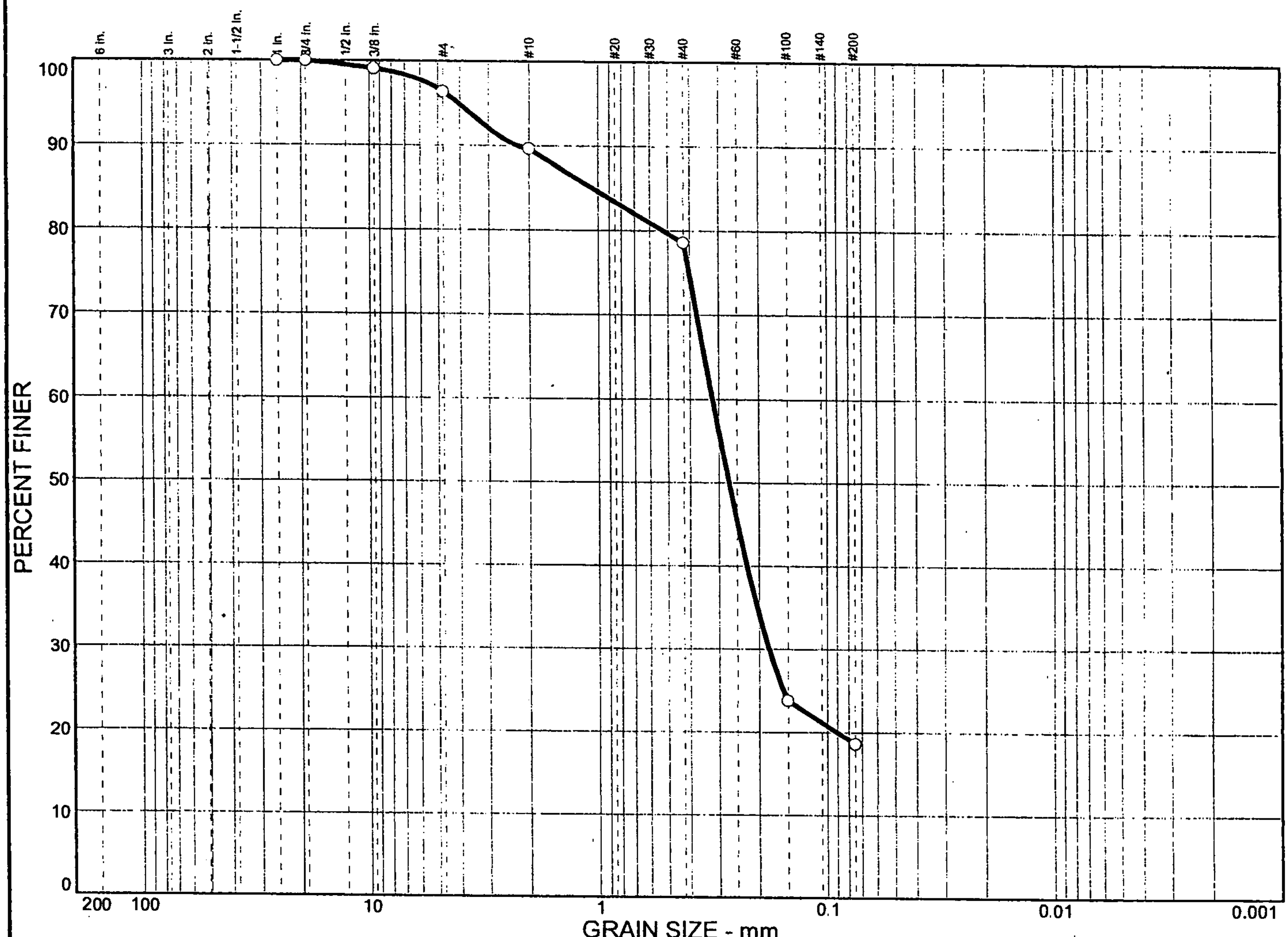
○ Natural Moisture = 27.1 %

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	3.6	77.8	18.6	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			1.06	0.319	0.271	0.181				

MATERIAL DESCRIPTION	USCS	AASHTO
○ Orange Brown to Greenish Brown, Silty F-M SAND, trace Clay & Shell	SM	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers

Project: Sharps Island

○ **Source:** S-19 **Sample No.:** S-7 **Elev./Depth:** 33.5'-35.0'

Remarks:

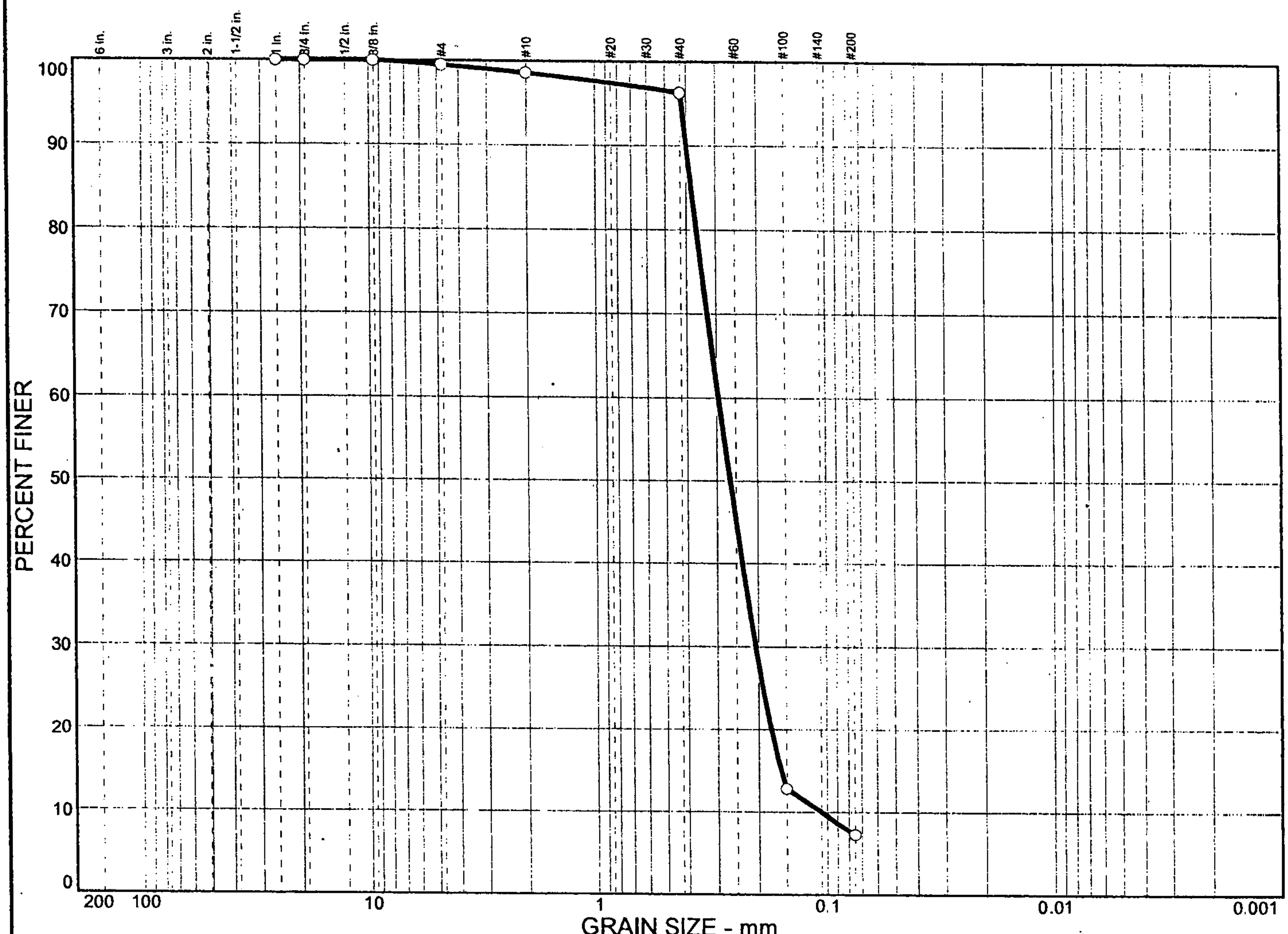
○ Natural Moisture = 23.8 %

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.5	92.2	7.3	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.380	0.295	0.264	0.206	0.158	0.105	1.36	2.80

MATERIAL DESCRIPTION	USCS	AASHTO
○ Gray, Fine SAND, trace Silt & Shell Fragments	SP-SM	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers

Project: Sharps Island

○ **Source:** S-23 **Sample No.:** S-6 **Elev./Depth:** 18.0'-20.0'

Remarks:

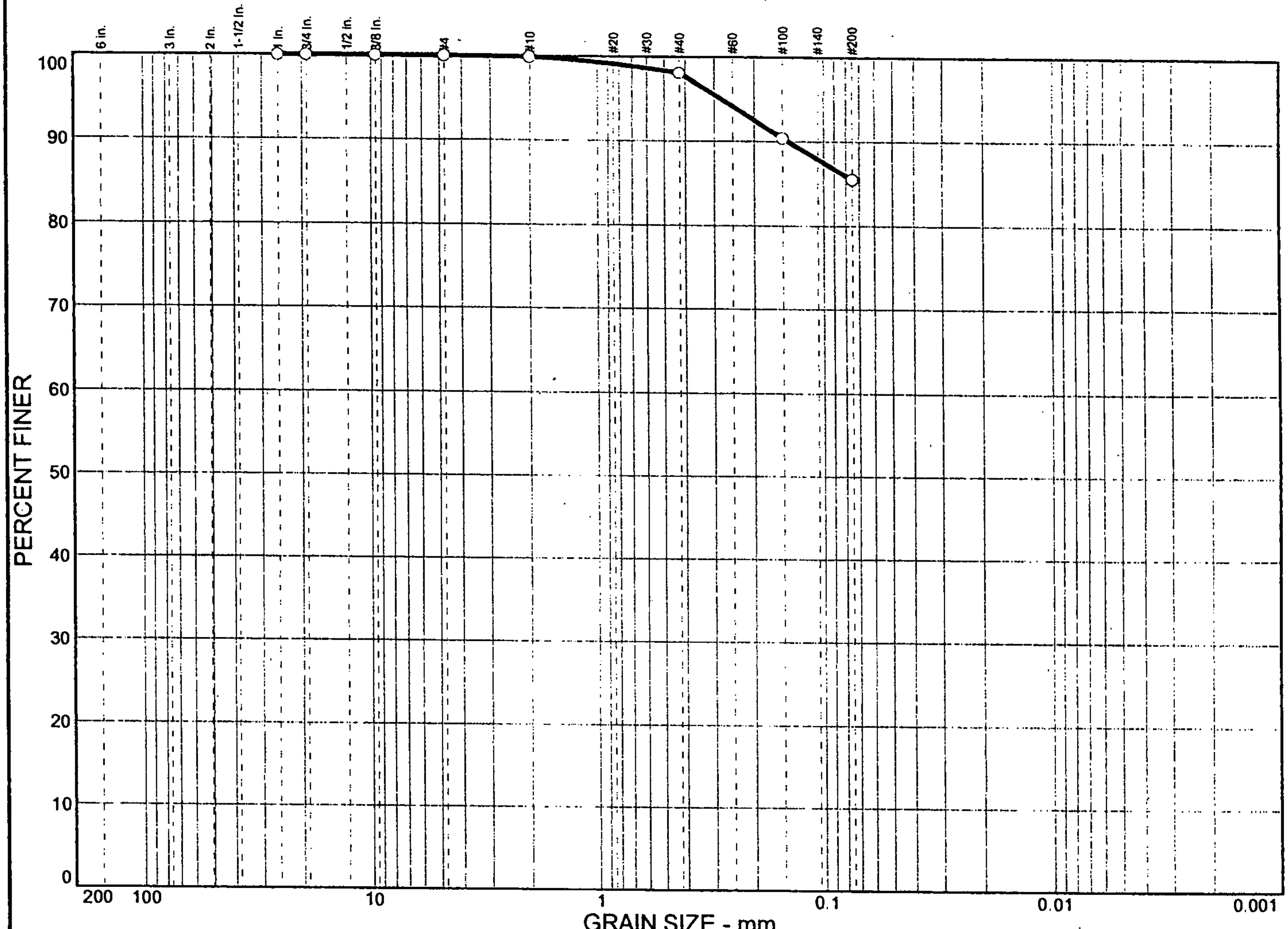
○ Natural Moisture = 29.3 %

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	14.5	85.5	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

MATERIAL DESCRIPTION	USCS	AASHTO
○ Gray-Orange Brown, Silty CLAY, little F.Sand, trace Shell	CL	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers
Project: Sharps Island

○ **Source:** S-25 **Sample No.:** S-2 **Elev./Depth:** 13.0'-15.0'

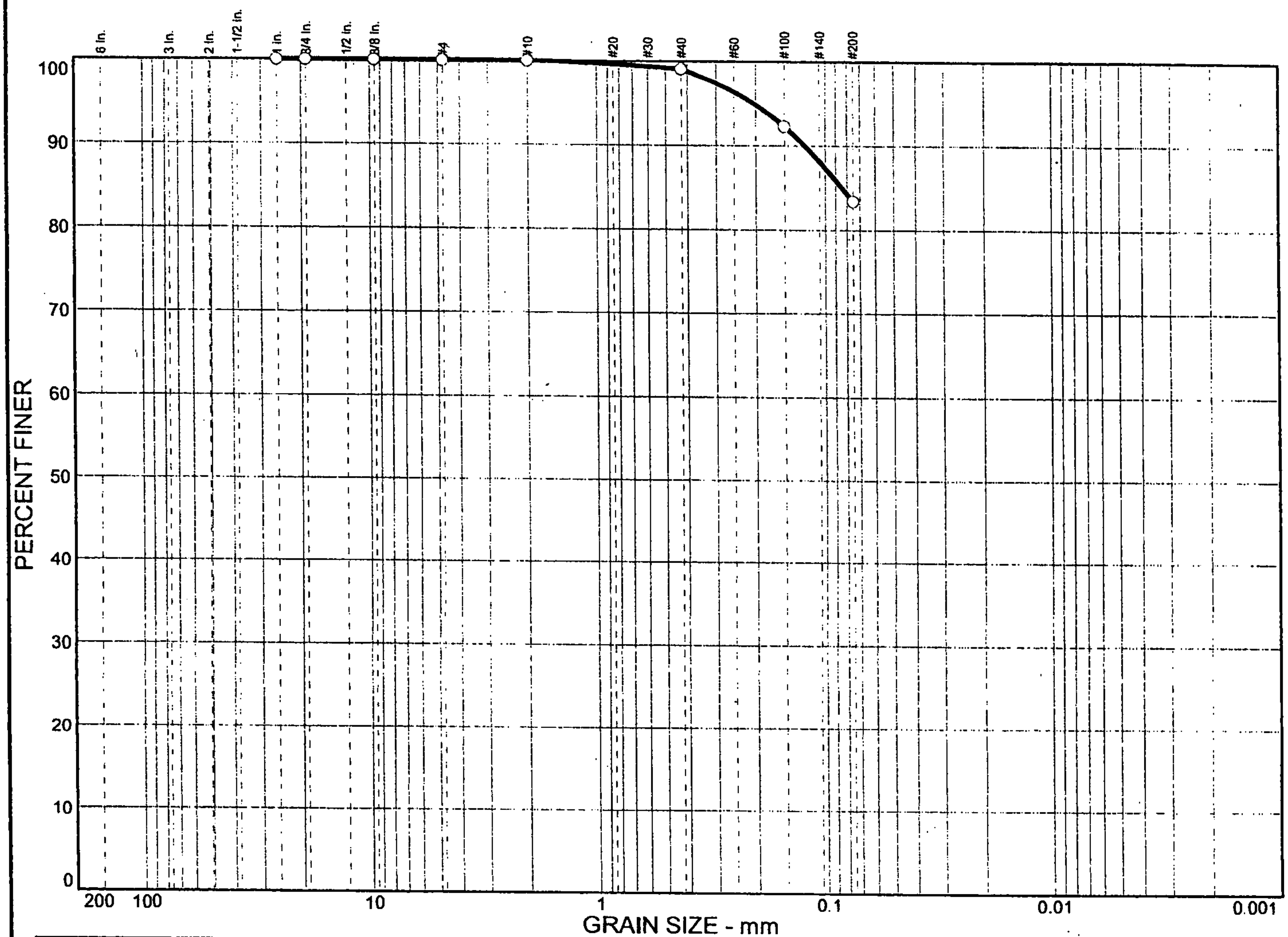
Remarks:
○ Natural Moisture = 48.3 %

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	16.6	83.4	

☒	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	47	23	0.0840							

MATERIAL DESCRIPTION	USCS	AASHTO
○ Greenish Gray, Silty CLAY, little F.Sand	CL	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers

Project: Sharps Island

○ **Source:** S-26 **Sample No.:** ST1 **Elev./Depth:** 24.5'-26.5'

Remarks:

○ Natural Moisture = 45.5%

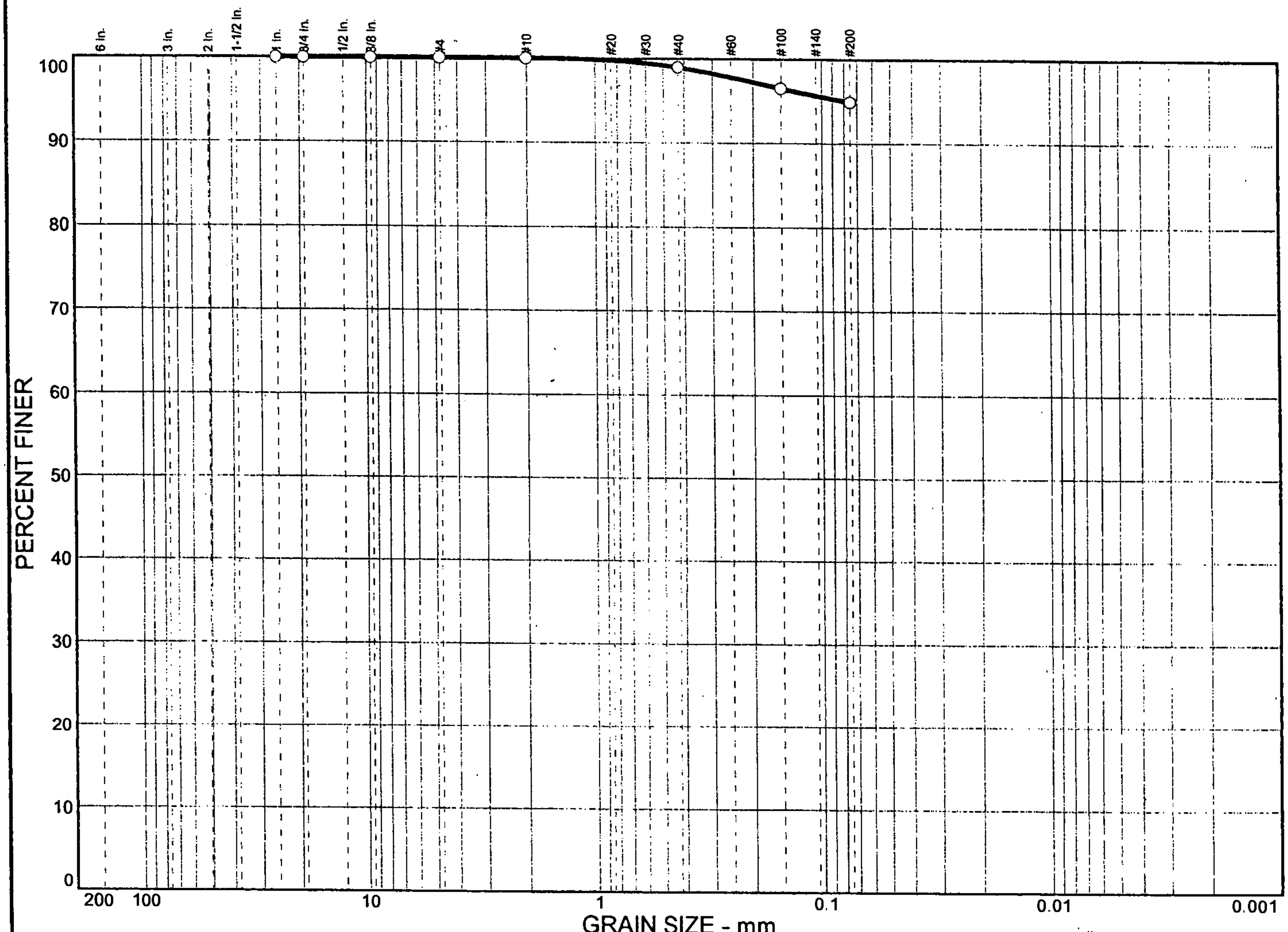
Plasticity Index = 24

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
○	0.0	0.0	5.1	94.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○										

MATERIAL DESCRIPTION	USCS	AASHTO
○ Greenish Gray, Silty CLAY, trace Fine Sand	CL	

Project No. 01583-04 **Client:** Moffatt & Nichol Engineers

Project: Sharps Island

○ **Source:** S-27 **Sample No.:** S-5 **Elev./Depth:** 23.5'-25.0'

Remarks:

○ Natural Moisture = 48.9 %

Particle Size Distribution Report

E2CR, Inc.

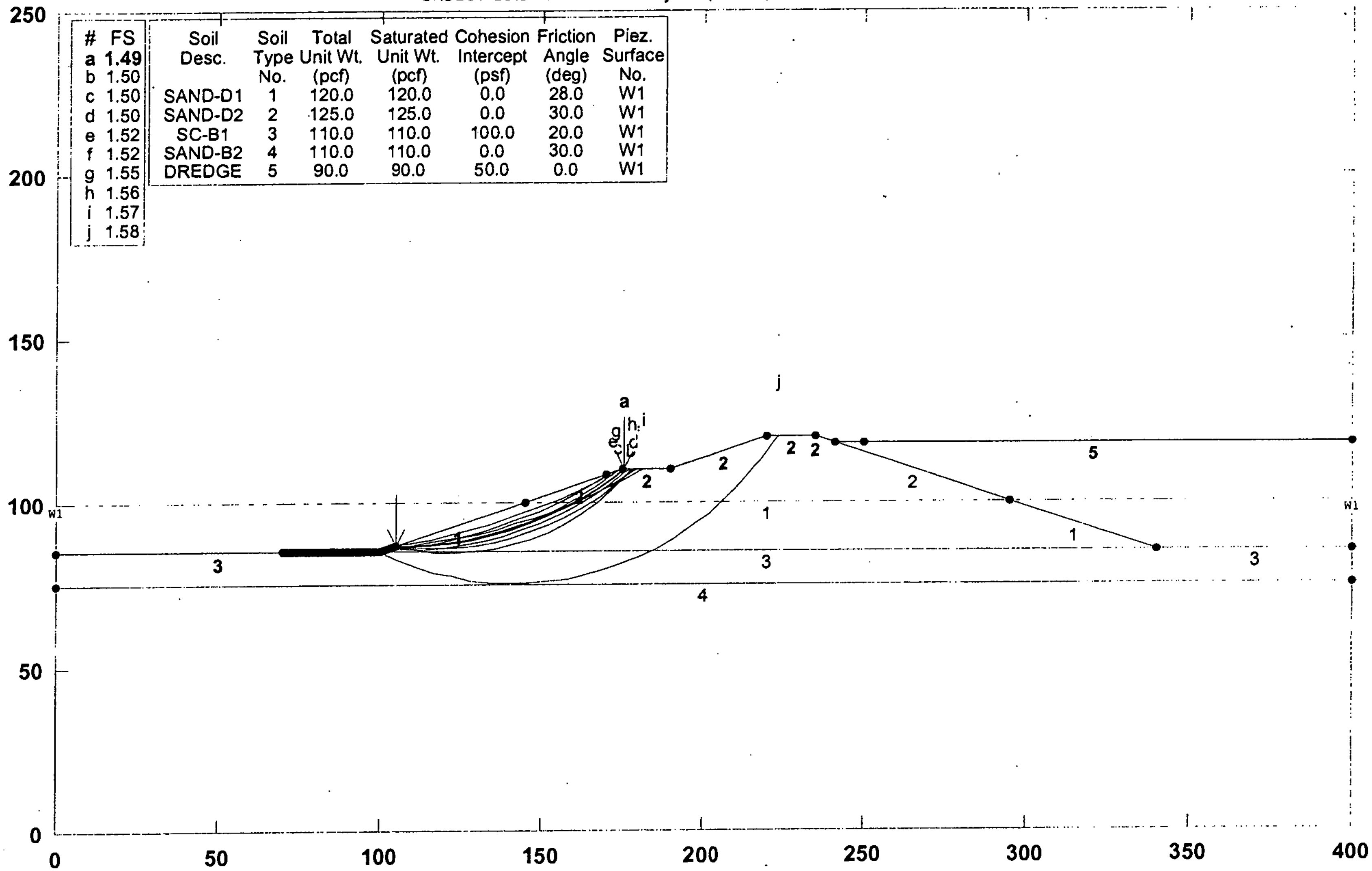
Plate

APPENDIX-E

SLOPE STABILITY ANALYSIS

SHARPS ISLAND : CASE-I PRELIMINARY STUDY, DIKE TO EL. +20

C:\SLOPE5\SI-2A.PL2 Run By: NS, E2CR, INC. 06/27/2002 5:18PM



#	FS
a	**1.49**
b	1.50
c	1.50
d	1.50
e	1.52
f	1.52
g	1.55
h	1.56
i	1.57
j	1.58

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
SAND-D1	1	120.0	120.0	0.0	28.0	W1
SAND-D2	2	125.0	125.0	0.0	30.0	W1
SC-B1	3	110.0	110.0	100.0	20.0	W1
SAND-B2	4	110.0	110.0	0.0	30.0	W1
DREDGE	5	90.0	90.0	50.0	0.0	W1

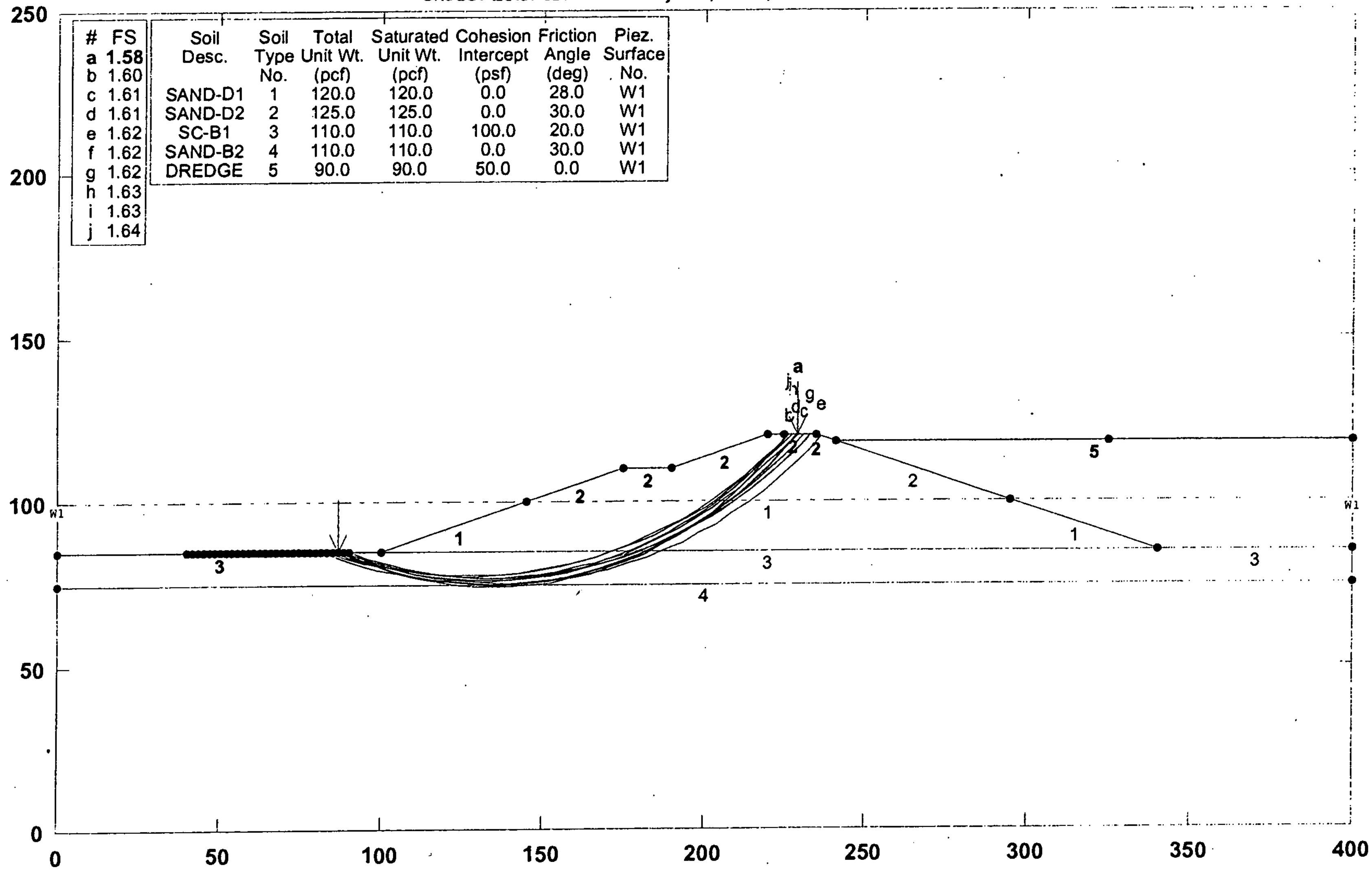
PCSTABL5M/si FSmin=1.49

Safety Factors Are Calculated By The Modified Bishop Method

STED

SHARPS ISLAND : CASE-I PRELIMINARY STUDY, DIKE TO EL. +20

C:\SLOPE5\SI-2B.PL2 Run By: NS, E2CR, INC. 06/27/2002 5:38PM



PCSTABL5M/si FSmin=1.58

Safety Factors Are Calculated By The Modified Bishop Method

STED

SHARPS ISLAND : CASE-II PRELIMINARY STUDY, DIKE TO EL. +20

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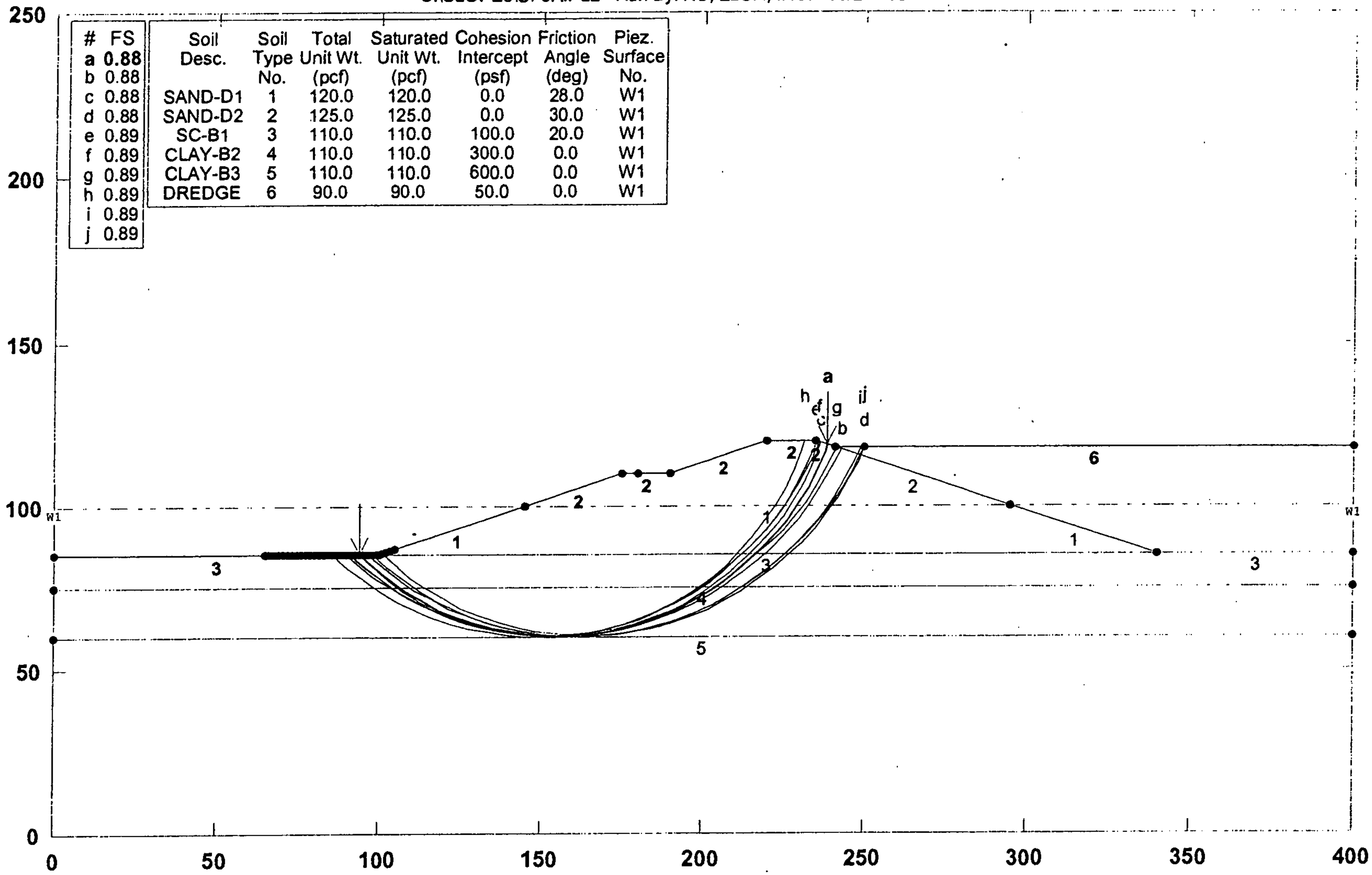

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Safety Factors Are Calculated By The Modified Bishop Method

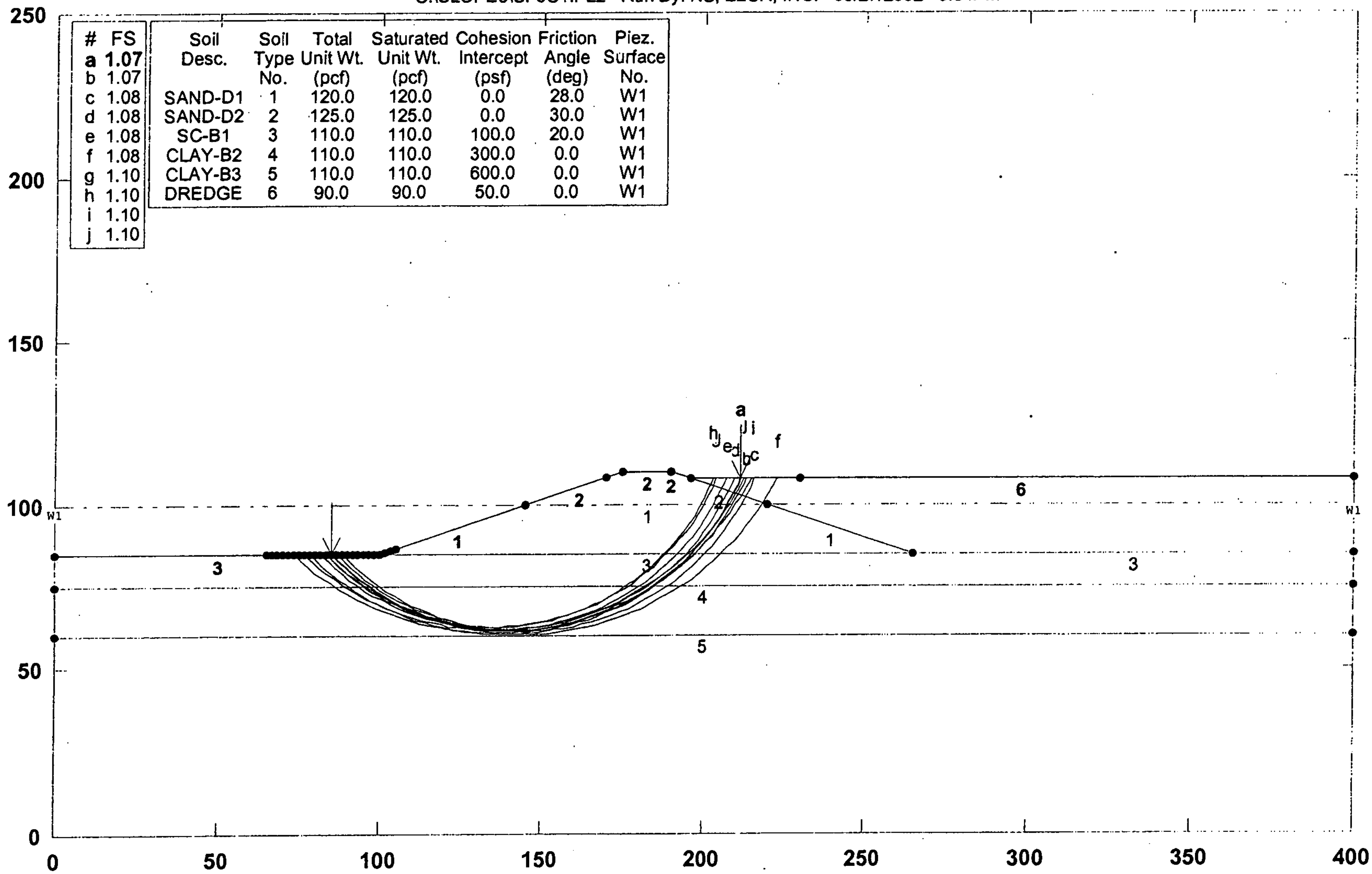
STED

SHARPS ISLAND : CASE-II PRELIMINARY STUDY, DIKE TO EL. +10

C:\SLOPE5\SI-3C1.PL2 Run By: NS, E2CR, INC. 06/27/2002 5:54PM

#	FS
a	1.07
b	1.07
c	1.08
d	1.08
e	1.08
f	1.08
g	1.10
h	1.10
i	1.10
j	1.10

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Piez. Surface No.
SAND-D1	1	120.0	120.0	0.0	28.0	W1
SAND-D2	2	125.0	125.0	0.0	30.0	W1
SC-B1	3	110.0	110.0	100.0	20.0	W1
CLAY-B2	4	110.0	110.0	300.0	0.0	W1
CLAY-B3	5	110.0	110.0	600.0	0.0	W1
DREDGE	6	90.0	90.0	50.0	0.0	W1



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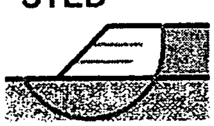
Safety Factors Are Calculated By The Modified Bishop Method

STED



APPENDIX D

ENVIRONMENTAL CONDITIONS REPORT

REPORT

Reconnaissance Study of Environmental Conditions at Sharps Island

Prepared for:
Maryland Environmental Service
Under Contract to:
Andrews, Miller and Associates, Inc.
Cambridge, MD

September 2002

BBL®
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

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Executive Summary

Maryland Environmental Service (MES), under sponsorship by the Maryland Port Administration, is examining the feasibility and suitability of potential placement sites throughout the upper Chesapeake Bay region to determine if they are suitable candidates for dredged material placement. The historical Sharps Island footprint is being considered for possible creation of a wetland and upland island habitat. MES has retained Andrews Miller and Associates (AMA) to conduct an Environmental Conditions Reconnaissance of Sharps Island (Figure 1-1). Blasland, Bouck and Lee, (BBL) is working as a sub-contractor to AMA for the Sharps Island project. BBL's role is to provide an Environmental Conditions Reconnaissance of Sharps Island.

Sharps Island completely disappeared in the early 1960s, possibly due to a variety of physical and environmental factors (Hanks, 1975). Currently, the submerged footprint of Sharps Island is all that remains since the island's disappearance in the early 1960s (Hanks, 1975). The only visible sign of its presence is the Sharps Island lighthouse. Built in 1838, the original Sharps Light has been replaced several times and moved over the years. The current lighthouse was damaged by ice in 1977, and remains on a lean. In 1982, the Sharps Light was added to the National Register of Historic Places. The lighthouse is currently in use today.

The proposed concept areas will create approximately 1,070 to 2,260 acres of land at the site, equally divided into wetland and upland habitat (BBL, 2002). These designs will provide the proper conditions for submerged aquatic vegetation (SAV) growth in protected shallow waters and for tidal marshes. At the present time, water conditions experienced at the mouth of the Choptank River due to water speed and wind action prevent the occurrence of SAV growth. The formation of land at this site through dredged material placement will help reduce wave action growth in the vicinity of Sharps Island. The reduction of wave action in this area will create potential SAV habitat and may lead to potential SAV growth. Along with wetland and upland habitat, SAV and marsh vegetation growth can provide key habitats for many invertebrates, fish, and waterfowl that use SAV beds, tidal marshes, and shallow shoreline margins as nursery areas and for refuge.

Due to the open location of Sharps Island, these waters continuously shift with the tides and thus undergo extreme environmental fluctuations throughout the year. In the summer, the waters become very hot with little moderation in temperature. In winter, ice has covered this section of the Bay as noted in historical records (USCG, 2002). Weather and runoff also constantly change the salinity of these shallow waters. Spring rains lead to the runoff of sediment and nutrients into the Choptank River, whose water pass through the Sharps Island vicinity as they enter the mainstem Chesapeake Bay (CBP, 2002). Aquatic conditions in the Sharps Island vicinity are variable depending on season, time of day, tide and weather. Blue crabs, spot, striped bass, waterfowl, waterbirds, raptors, and other species inhabit the vicinity.

Maryland's Chesapeake Bay Water Quality Monitoring Program measures various parameters near Sharps Island. Approximate surface water temperatures in the vicinity of Sharps Island range from 1–10°C in the winter, up to 20–27°C in the summer. Surface salinity in the vicinity of Sharps Island ranges for the most part within a mesohaline salinity regime, from 2–12 parts per thousand (ppt) during spring runoff and from 9–18 ppt in the fall and winter. Dissolved oxygen measurement ranges from 1998–1999 were approximately 4.5 to 6.2 mg/L in the summer and 8.8 to 9.2 mg/L in the spring. Annual water clarity Secchi depth readings in the Outer Choptank River from 1985–1999 ranged from 4.25 to 6 feet. Current Mean Lower Low Water (MLLW) depths are shallower along the east and south shorelines, ranging from approximately -5.0 to -9.0 feet, while the northern and western footprint of the island ranges from approximately –8.0 to –11.0 feet. Typically, depths around 6 feet or less and visibility reaching this depth is required for SAV growth. There are no records of SAV presence in the Sharps Island vicinity.

Site-specific bottom composition in the Sharps Island area include loose to dense clayey sands underlain by loose to dense silty sands (AMA, 2002). Based on sediment composition, the area is suitable to support the full suite of benthic invertebrate species expected in the Mid Chesapeake Bay (CBP, 1998), under acceptable ranges of water quality parameters suitable for aquatic life.

Sharps Island and the immediate vicinity offer habitat to both macro and micro benthic invertebrates (Funderburk et al., 1991). Of the larger invertebrate species, blue crab (*Callinectes sapidus*), eastern oyster (*Crassostrea virginica*), and soft shell clam (*Mya arenaria*) are key components to the Bay's ecosystem, and the economy of Maryland. Since the island became completely submerged in the early 1960s, bird habitat has been lost. The only potential location for nesting, foraging, and nesting within the vicinity is the use of the lighthouse, Sharps Light. However, it is likely that waterfowl and other waterbirds inhabit the area at least occasionally. Maryland's Rare, Threatened and Endangered Species list includes five sea turtle species that could occasionally pass by this location. Of the RTE aquatic species on Maryland's list, sea turtle species have the potential to occur in the Sharps Island vicinity (Table 4-3). Of these RTE species, NMFS has stated that the Loggerhead turtle will be negatively impacted, and that the Kemps Ridley turtle may be negatively impacted in the Sharps Island vicinity (Nichols, 2002). It should be noted that marine turtles are transients in open water habitats, and that there may not be an overall impact on sea turtles (USFWS, 2002).

Commercial and recreational resources in the Chesapeake Bay include many valuable finfish and shellfish species. The mid-section of the Chesapeake Bay supports diverse commercial and recreational resources. Recreational fishing locations in the immediate vicinity of Sharps Island are presented in Figure 4-2. Finfish species that occur or have the potential for existing in the mid Chesapeake Bay mesohaline environment are listed in Table 4-2 (CBP, 1998). Essential Fish Habitat (EFH) includes waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity (NMFS, 2002). Site–specific EFH include Bluefish, Summer flounder, Spanish Mackerel and Red Drum. These four EFH species are included as species of concern for the Sharps Island vicinity (Table 4-1).

The Maryland Department of Natural Resources (MDNR) keeps commercial finfish data for the Chesapeake Bay. Although there are no specific data for Sharps Island, the database provides information for two nearby areas, categorized by National Oceanic and Atmospheric Administration (NOAA) codes 027 (Southern Central Portion of the Chesapeake Bay) and 037 (Choptank River). The locations of these harvest areas as well as other harvest areas are found in the vicinity of Sharps Island. MDNR's website provides commonly referred to fishing locations in the Mid Chesapeake Bay (Figure 4-2). As per this figure, known recreational fishing locations within 3-4 km of Sharps Island include: the Hook (north), Devil's Hole (northwest), Stone Rock (southeast) and Diamonds (south) [MDNR, 2002c]. However, Proposed Concept Area designs will directly affect site-specific recreational fish grounds to the west of the Sharps Island site, as presented in Figure 4-2 indicate. In addition, dredge material placement activities may affect recreational fishing activities within 1 mile to the north and to the east of the Sharps Island site.

Throughout the Chesapeake Bay, sediment may potentially contain unexploded ordnance (UXO) as the result of historical military and naval activities. Based on military documentation, munitions testing and training activities occurred on Sharps Island and it is possible that UXO are present.

Proposed Concept Area designs will provide the proper conditions for submerged aquatic vegetation growth at Sharps Island. The potential for SAV growth can provide key habitats for many invertebrates, fish and waterfowl that use SAV beds, tidal marshes and shallow shoreline margins as nursery areas and for refuge. Predators, including blue crabs, spot, striped bass, waterfowl, waterbirds and raptors, forage for food in this type of environment. Avian bird species populations will use the island for nesting and residence. In addition, the upland areas would become habitat for bird species, and has the potential to sustain mammals over time.

1. Introduction and Site Description

1.1 Project Background

Maryland Environmental Service (MES), under sponsorship by the Maryland Port Administration, is examining the feasibility and suitability of potential placement sites throughout the upper Chesapeake Bay region to determine if they are suitable candidates to be used for dredged material containment facilities. Typically, the sites that are selected for investigation are islands that have decreased significantly in size due to wave action or sea level rise. Also, shorelines that have eroded over time due to the same environmental factors are considered for the beneficial use of placement of dredged materials.

The historical Sharps Island footprint is being considered for possible creation of a wetland and upland island habitat. The original island completely disappeared in the early 1960s, possibly due to a variety of physical and environmental factors (Hanks, 1975). The historic footprint of Sharps Island is located approximately 4 miles southwest of Blackwalnut Point (Talbot County) and 4 miles west of Cook Point (Dorchester County) at the mouth of the Choptank River (Figure 1-1).

MES has retained Andrews Miller and Associates (AMA) to conduct an Environmental Conditions Reconnaissance of Sharps Island. Blasland, Bouck and Lee, (BBL) is working as a sub-contractor to AMA for the Sharps Island project.

1.2 Project Objectives

BBL's role is to provide this Environmental Conditions Reconnaissance of Sharps Island. This effort includes a literature search and review of existing resource information and potential impacts. Through research and consultation with commercial fisherman and sport fishing associations, the extent and locations of fishing, boating, and seasons of use has been evaluated. Essential Fisheries Habitat (EFH) and Habitat Area of Particular Concern (HAPC) at the site have also been assessed.

Parameters of concern including the following elements:

- Water quality
- Salinity
- Sediment quality
- Groundwater
- Benthic community and habitat
- Recreational community and fisheries
- Fisheries habitat, including Essential Fish Habitat
- Determination of locations of oyster reefs within the study area footprint
- Rare, threatened and endangered species (RTE)
- Submerged aquatic vegetation (SAVs)
- Shallow water habitat
- Avian and terrestrial species and habitat
- Tidal wetlands
- Recreational and socioeconomic value
- Historical and cultural resources

- Aesthetics and noise
- Critical areas
- Navigation.

These parameters are assessed and presented in report format.

1.3 Site Description

Sharps Island is located in the southern part of the Chesapeake Bay near the mouth of the Choptank River, the largest river on the Eastern Shore of Maryland. The island is located in Talbot County, Maryland, approximately 4 miles southwest of Blackwalnut Point, and approximately 4 miles west of Dorchester County.

Sharps Island Light marks the shoal of what once was a 900+ acre island in the Chesapeake Bay off the entrance to the Choptank River (Hanks, 1975). During the 19th century, Sharps Island was noticeably decreasing in size, possibly due to a variety of physical and environmental factors. By 1848, approximately half of the Island's acreage had been lost (Figure 1-2). Due to encroaching waters, the original lighthouse was replaced in 1866 and relocated 1/3 of a mile off the northern tip of the Island (USCG, 2002). By 1900, less than 100 acres remained. Sharps Island was reduced to approximately 10 acres by 1942. Finally, the last remaining land of Sharps Island disappeared under the waters of the Chesapeake Bay in the early 1960s (Hanks, 1975). Water depths upon the Sharps Island 1848 historic footprint vary from approximately –5.0 to –11.0 feet Mean Lower Low Water (MLLW) (AMA, 2002).

1.4 Proposed Concept Area

The proposed concept areas are presented in Reconnaissance Study of Dredging Engineering and Cost Estimate for Habitat Restoration at Sharps Island (BBL, 2002). The following subsection summarizes key habitat characteristics of the proposed concept areas, as outlined in this document.

There are five proposed dike sections. All proposed sections are divided equally into uplands and wetlands. Three of the proposed dike alignments range in size from 1,520 to 2,260 acres. In these proposals, uplands will be located in the western portion and wetlands will be located in the eastern portion of the proposed island. The remaining two dike alignments are 1,070 and 1,200 acres in size. In these proposals, uplands are located to the north and wetlands are located in the southern portion of the proposed island.

All of the proposed dike alignments partially overlap the original 1848 footprint. In the proposed concept areas, water depths are shallower along the east and south shorelines, with water depths ranging from –8.0 to –10.0 feet MLLW. Depths along the west and north sides are deeper, ranging between –11.0 and –14.0 feet MLLW (AMA, 2002). A portion of these alignments are located within the natural oyster bar in the vicinity of Sharps Island.

2. Habitat Description

The submerged footprint of Sharps Island is all that remains since the island's disappearance in the early 1960s (Hànks, 1975). At the present time, Sharps Island is completely submerged, and thus there are no tidal wetlands on site.

Current MLLW depths are shallower along the east and south shorelines, ranging from approximately -5.0 to -9.0 feet, while the northern and western footprint of the island ranges from approximately –8.0 to –11.0 feet. Based on data presented in the Coastal Engineering Reconnaissance Study for Sharps Island, Maryland tides within this portion of the Chesapeake Bay are semi-diurnal (twice daily), with a mean tide range of 1.35 feet; the mean tide level is 0.76 feet above MLLW (AMA, 2002).

The Sharps Island historical footprint acts as an open water shallow habitat for aquatic organisms. Due to the open location and shallow water at Sharps Island, these waters respond continuously to physical effects of wind, waves, currents, weather, and tides and thus undergo extreme environmental fluctuations throughout the year. In the summer, the waters become very hot with little moderation in temperature. Historical records document extreme winter weather conditions, in which ice has formed in the vicinity of Sharps Island. In February of 1881, ice flows sheared the Sharps Island lighthouse from its piles and carried it for five miles down the Bay (USCG, 2002). In 1977, the current lighthouse was damaged by ice, and remains on a lean (NPS, 2002). Heavy rain storms also constantly change the salinity of these shallow waters. Spring rains lead to the runoff of sediment and nutrients into the Choptank River, whose waters carry these materials through the Sharps Island vicinity as they enter the mainstem Chesapeake Bay (CBP, 2002).

Shallow waters are constantly being affected by wind and storms, which suspend sediments throughout the water column. Given its location within the Chesapeake Bay, Sharps Island is especially affected by winds from northern, northwestern, southwestern, and southern directions generating higher wave heights (AMA, 2002). Higher waves and current flow within the Chesapeake Bay, coupled by Choptank River currents, result in more enhanced current action upon the footprint of Sharps Island.

While aquatic life is present in the Sharps Island area, the lack of SAV habitat due to the effect of these physical forces upon this open water habitat limits the area's productivity in relation to other shallow water shoreline habitats in the Chesapeake Bay (CBP, 2002).

3. Water and Sediment Quality

3.1 Water Quality

Overall, the Chesapeake Bay has a mean depth of 25 feet. The deepest areas at approximately 125 feet below water levels are found near the mouths of the Choptank River and Chester River. Deep water is located approximately 1 mile to the west and 0.5 mile to the southeast of the Sharps Island 1848 footprint. The deepest depths are part of a large, winding channel that extends the length of the bay (USGS, 1986). Average tidal range varies from no influence at the upper reaches of the Chesapeake Bay, to about 3 feet at the mouth of the Chesapeake Bay, near Norfolk, Virginia (USGS, 1986). The Choptank River, the largest river on Maryland's Eastern Shore, receives stream flow from the 795-square-mile Choptank River Basin (Belval and Sprague, 1999). Water from the Choptank mixes with mainstem Chesapeake Bay waters in the mid Chesapeake Bay, including the vicinity of Sharps Island.

Major environmental measures of water quality include salinity, temperature, dissolved oxygen (DO), and Secchi depth readings (a measure of water clarity). These measures are described in detail in the following subsections.

3.1.1 Water Quality Monitoring

The closest continuous-monitoring water quality station near Sharps Island is known as Choptank River Mainstem Bay Station CB4.2C. This monitoring station is located west of the Choptank River, and has a station depth of approximately 88 feet. This location is west of Sharps Island and at much greater depths, and therefore most likely has differing water quality parameter ranges than present at Sharps Island. Of the parameters measured at this location, surface temperature and surface salinity data would be most consistent with the Sharps Island area. Monitoring data for surface temperature and surface salinity, taken at this station continuously from 2001 to mid-2002 are presented in Figure 3-1 (CBP, 2002).

In addition, Maryland's Chesapeake Bay Water Quality Monitoring Program has a monitoring station east of Sharps Island (EE2.1) located in the Outer Choptank River between Todd's Point and Nelson Point, near Coast Guard Buoy R-12. Long-term grab sample water quality monitoring has been collected throughout the Bay since 1984. Summary data for water clarity, and spring/summer DO levels are presented in Figures 3-2 to 3-4 (CBP, 2002).

3.1.1.1 Temperature

Temperature dramatically affects the rates of chemical and biochemical reactions in the water. Many biological, physical, and chemical processes are temperature dependent, including the distribution, abundance, and growth of living resources, the solubility of compounds in sea water, rates of chemical reactions, density, mixing, and current movements. Because the Bay is so shallow, its capacity to store heat over time is relatively small and water temperature varies within a narrow range each season. As a result, water temperature in the Bay fluctuates considerably on an annual basis (CBP, 2002). Surface water temperature in the vicinity of Sharps Island ranges from 1–10°C in the coldest winter months, up to 20–27°C in the warmest summer months (Mid-Chesapeake Bay Station CB 4.2C 2001-2002 data: CBP, 2002). Annual surface water temperature ranges are presented as part of Figure 3-1.

3.1.1.2 Salinity

Salinity levels directly affect the distribution and well-being of the various aquatic species living in the Bay. For example, anadromous finfish (e.g.. rockfish) spawn in fresh water with salinities close to or equal to zero parts per thousand (ppt) and live the rest of their lives in high salinity waters at sea. Oysters can live only within a narrow salinity range. Salinity also affects the density of the water which is an important factor to the mixing of oxygen rich surface waters with the oxygen depleted bottom waters. In addition, salinity is seasonally dependent on the amount of freshwater, or streamflow, entering the Bay (CBP, 2002). Drought-like conditions like those experienced in Summer 2002 affect the Bay's salinity.

Chesapeake Bay salinity ranges from tidal fresh at the head of the estuary to polyhaline at its mouth; this range covers the full salinity regime. *Tidal fresh* conditions (salinity between 0 - 0.5 ppt) are found at the extreme northern reaches of tidal influence in the Upper Chesapeake Bay. *Oligohaline* conditions (0.5 - 5 ppt) are typically found in the upper portion of an estuary. *Mesohaline* conditions (5 - 18 ppt) are typically found in the middle portion of an estuary. Finally, *polyhaline* conditions (18 - 30 ppt) are typically found in the lower portion of an estuary, where the ocean and estuary meet.

Based on its central location within the Chesapeake Bay, and its position within the outflow of the Choptank River, the Sharps Island area is expected to have mesohaline salinity regime. Monitoring data for the Sharps Island vicinity confirms this assumption. Surface salinity in the vicinity of Sharps Island ranges from 2–12 ppt during spring runoff, and from 9–18 ppt in the fall and winter (Mid-Chesapeake Bay Station CB 4.2C; 2001–2002 data: CBP, 2002). Seasonal and tidal salinity ranges for the Sharps Island vicinity are presented as part of Figure 3-1. To note, the Mid-Chesapeake Bay Station CB 4.2C data is expected to record slightly higher salinity levels than those found at Sharps Island, which is closer to Choptank River freshwater source. Essential Fish Habitat (EFH) species associated with mesohaline salinity conditions are discussed in Section 4.

3.1.1.3 Water Clarity

Clear water absorbs less light than turbid water, allowing more light energy to reach primary producers like SAV and phytoplankton. Secchi depth is the depth at which a specially marked disk, when lowered into the water, is no longer visible to the naked eye. The greater the depth at which the Secchi disk disappears from view, the clearer the water. Thus, Secchi depth readings are used as a general measure of water clarity (CBP, 2002). Maryland's Chesapeake Bay Water Quality Monitoring Program measure Secchi depth readings the Outer Choptank River. Annual measurements at this location taken between 1985 and 1999 range from 1.3-1.8 meters (Figure 3-2).

3.1.1.4 Dissolved Oxygen (DO)

DO is a major factor affecting the survival, distribution, and productivity of living resources in Chesapeake Bay. Low DO levels reduce available habitat and adversely impact the growth, reproduction, and survival of the Bay's fish, shellfish and bottom dwelling organisms (CBP, 2002). Much of the deep water of the Chesapeake Bay mainstem becomes anoxic during summer months and is therefore nearly devoid of animal life (Jordan et al, 1992). Data from 1985–1989 within the Chesapeake Bay Program report, Habitat Requirements for Chesapeake Bay Living Resources, indicates that the Sharps Island vicinity does not seem to have low summer DO readings (Funderburk *et al*, 1991). Maryland's Chesapeake Bay Water Quality Monitoring Program measures DO in the Outer Choptank River. DO measurement ranges in 1998–1999 range from 4.5 - 6.2 mg/L in the Summer, and 8.8 - 9.2 mg/L in the Spring (CBP, 2002). Long-term DO measurement recordings for the Sharps Island vicinity are presented in Figures 3-3 and 3-4.

3.2 Sediment Quality

The Chesapeake Bay lies in the Atlantic Coastal Plain, and the sedimentary strata underlying the bay and exposed shores consist mostly of unconsolidated gravel, sand, clay, and marl (USGS, 1986). Between 1976 and 1984, the Coastal and Estuarine Geology Program collected 4,255 surficial sediment grab samples in the main portion of the Chesapeake Bay (Maryland Geologic Survey, 2002). The bottom sediments were classified according to Shepard's Ternary Classifications, based upon the proportions of sand-, silt- and clay-sized particles (Shepard, 1954). Based on this data and the Shepard's Ternary Classification, surface sediment in the Sharps Island vicinity consists of 50–100% sand mixed with silt, as indicated in Figure 3-5 (Maryland Geologic Survey, 2002).

Based on data provided by the Maryland Department of Natural Resources (MDNR, 2002c), bottom composition in the Proposed Concept Area includes mud, sand, cultch, and a mix of mud and/or sand with cultch (Figure 3-6). To note, cultch is a rock and/or shell bottom. As clams and oysters metamorphose into juveniles, they search for this type of habitat.

The Geotechnical Report (Pre-Feasibility Study) for Sharps Island, Chesapeake Bay, Maryland provides boring data for the site (E2CR, 2002). In addition, limited boring data for the site is available in Coastal Engineering Reconnaissance Study for Sharps Island, Maryland (AMA, 2002). Based on data collected upon the proposed foundation sediment at the Sharps Island historic footprint and the immediate vicinity, sediments at this site are mostly loose to dense clayey sands underlain by loose to dense silty sands (AMA, 2002).

Based on the above supporting sources of sediment data, the Sharps Island area is suitable to support the full suite of benthic invertebrate species expected in the Mid Chesapeake Bay (CBP, 1998), as long as water quality parameters fall within acceptable ranges suitable for aquatic life.

4. Biological Resources

4.1 Essential Fish Habitat

The Magnuson-Stevens Conservation and Management Act of 1996 identifies and protects habitats of federally managed fish species. The determination of Essential Fish Habitat (EFH) was part of this Act. Congress broadly defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (NMFS, 2002). Availability of native forage species is the preeminent reason that the Chesapeake provides EFH for so many species. Various shrimp, small fish, and benthic invertebrates are important to the bottom feeders. Menhaden, silversides, and Bay anchovy are among the key prey species for the more pelagic predators. Any federal agency that funds, permits or undertakes activities that may be detrimental to EFH are required to consult with the National Marine Fisheries Service (NMFS). Based on MDNR data, the Proposed Concept Area is not designated as critical finfish habitat (MDNR, 2002c).

4.2 Habitat Area of Particular Concern

The only Habitat Area of Particular Concern (HAPC) in the mid Chesapeake Bay is Submerged Aquatic Vegetation (SAV); however, SAV HAPC is exclusive to juvenile Red Drum, and adult and juvenile Summer flounder (Nichols, 2002). Presently, there is no occurrence of SAV in the Sharps Island vicinity. However, the Proposed Concept Area designs provide the proper conditions for SAV growth in protected shallow waters and for tidal marshes. Since Sharps Island lies within the distribution range for Summer flounder and Red Drum, creation of conditions of potential SAV HAPC may lead to occurrences of these species in the Sharps Island area.

4.3 Fish

Commercial and recreational resources in the Chesapeake Bay include many valuable finfish and shellfish species. In particular, the mid-section of the Chesapeake Bay supports diverse commercial and recreational resources. Common fishing locations in mid Chesapeake Bay are presented in Figure 4-1. Area-specific recreational fishing locations in the immediate vicinity of Sharps Island are presented in Figure 4-2.

There are nine EFH species managed by NMFS. These species include Windowpane flounder (*Scophtalmus aquosos*), Bluefish (*Pomatomus saltatrix*), Atlantic Butterfish (*Peprilus triacanthus*), Summer flounder (*Paralichthys dentatus*), Black Sea Bass (*Centropristis striata*), King Mackerel (*Scomberomorus cavalla*), Spanish mackerel (*Scomberomorus maculates*), Cobia (*Rachycentron canadum*) and Red Drum (*Sciaenops occelatus*).

Windowpane flounder inhabit estuaries and near-shore waters. Spawning occurs during most of the year and peaks in summer months. During winter they are known to migrate to deeper offshore waters. Juveniles and adults are common in the mainstem of the Chesapeake Bay in mesohaline areas. As a result of their preference for sand, mud, and silt substrates, windowpane flounder are caught as a by catch in bottom trawl fisheries.

Bluefish inhabit the continental shelf waters of warm temperate zones, and range from Nova Scotia to Texas. They are found in the Chesapeake Bay from Spring through to Autumn both offshore and nearshore traveling in schools. Bluefish migrate south for the winter season. Spawning occurs in spring and summer, peaking in summer.

Atlantic butterfish inhabit a range from Newfoundland to Florida, and spend the winter season close to the edge of the continental shelf in the Middle Atlantic Bight. In summer butterfish can be found along the entire mid-Atlantic shelf including bays and estuaries. Spawning occurs in late May and peaks in June and July.

Summer flounder are also found from Nova Scotia to Southern Florida. They can be found in the Chesapeake Bay in summer and then move offshore in the winter. Flounder are found in the deeper channels of the Bay, and as with other flounder species are bottom dwellers. Spawning occurs from late summer to mid winter.

Black sea bass occur from Nova Scotia to Southern Florida and inhabit structured habitats such as reefs, pilings, wrecks and oyster beds on the continental shelf. They are a migratory species that are found in the Bay during the summer months and then migrate south and offshore for the winter.

King mackerel are found in coastal waters from Maine to Mexico. Their occurrences in the Chesapeake Bay are more often in the middle and lower Bay. They are surface dwellers found near shore. Spawning occurs from May through to October. These fish are migratory and move south for wintering.

Spanish mackerel are found in the same range as the King mackerel. These fish inhabit shallow coastal ocean waters, but will enter tidal estuaries and are common in the Chesapeake Bay from spring to autumn. Similar to the King mackerel, they are surface dwelling, near shore species. Spawning occurs off the coast of Virginia from late spring to late summer.

Cobia are found from the Mid-Atlantic States to as far south as Argentina. They migrate to Florida during the winter and move north to spawning and feeding ground in the summer months. Cobia eggs and larvae are frequently observed in the Chesapeake Bay waters in the summer.

Red drum are found from Maine to northern Mexico. Adults can be found in the Chesapeake Bay from May though to November and are most abundant in the spring and fall near the mouth of the Bay. During mild winters they may overwinter in the Bay but generally they migrate seasonally moving offshore and south. Spawning occurs in near shore coastal waters from late summer into the fall.

Of these EFH fish, Cobia, King Mackerel, Atlantic Butterfish, and Black Sea Bass do not generally occur in Maryland waters of the Bay and would not be expected in the vicinity of Sharps Island (Nichols, 2002). The occurrence of Windowpane flounder in the vicinity of Sharps Island would be rare. In addition, this species is not a recreationally or commercially important fish. Bluefish and Summer flounder may occur in general area of Sharps Island. In addition, Spanish Mackerel and Red Drum may occur as far north as the Choptank River. These four EFH species are included as species of concern for the Sharps Island vicinity (Nichols, 2002). Table 4-1 details the seasonal frequency and life stage presence of these species of concern for Sharps Island.

While these species fall under the EFH classification, numerous commercial and recreational fish can be found in the Chesapeake Bay's waters. Table 4-2 lists finfish species that occur or have the potential for existing in the mid Chesapeake Bay mesohaline environment near Sharps Island (CBP, 1998).

4.4 Benthos

The benthic community of the Chesapeake Bay represents an important ecological niche. While some benthic invertebrates are food for higher trophic organisms (fish, birds), some serve as an important commercial harvest. Based on the summary maps provided in *Habitat Requirements for Chesapeake Bay Living Resources* (Funderburk et al., 1991), Sharps Island and the immediate vicinity offer habitat to both macro and micro benthic invertebrates. Of the larger invertebrate species, blue crab (*Callinectes sapidus*), eastern oyster (*Crassostrea virginica*), and soft shell clam (*Mya arenaria*) are key components to the Bay's ecosystem, and the economy of Maryland.

Seasonal habitat distributions of blue crab vary. Males are found at their highest density in the summer and at low densities during the winter (MDNR, 2002c). Females are found at low densities in the summer months. While Sharps Island is not proximate to blue crab spawning areas at the mouth of the Chesapeake Bay, this area has the characteristics of foraging and refuge habitat for blue crabs.

Present-day and historic Sharps Island includes eastern oyster habitat, as indicated in Figure 4-3. Based on this figure, natural oyster bar boundaries lie within the footprint of Sharps Island. In 1910, a delineation of natural oyster bar boundaries in the vicinity of Sharps Island was performed by the Maryland Shell Fish Commission, in cooperation with the US Coast and Geodetic Survey and US Bureau of Fisheries (NOAA. 2002). Natural oyster bars in the vicinity of Sharps Island during this survey included (Appendix A): Stone (3,273 acres northwest), Clay Bank (1,512 acres west), Hills Point (1,644 acres southeast), and Diamond (800 acres east).

The soft shell clam has a potential habitat density distribution greater than 1 clam per square meter in the Sharps Island vicinity. However, based on MDNR data (2002c), the Proposed Concept Area is designated as having a low abundance of shellfish.

4.5 Submerged Aquatic Vegetation (SAV)

SAV is comprised of rooted flowering plants that have colonized primarily soft sediment habitats in typically protected freshwater, coastal, and estuarine habitats (Dennison et al., 1993). The well-defined linkage between water quality and SAV distribution and abundance make these communities good barometers of the health of estuarine ecosystems. SAV is important not only as an indicator of water quality, but it is also a critical nursery habitat for many estuarine species. Blue crab post-larvae are 30 times more abundant in SAV beds than adjacent unvegetated areas. Similarly, several species of waterfowl that remain in the Chesapeake region for the winter season depend upon SAV for food (MDNR, 2002a).

SAV thrive in areas that can support their demanding specifications. Basically, the minimal light requirement of a particular SAV species determines the maximal water depth at which it can survive (Dennison et al., 1993). Typically, minimal light requirements are consistent for each species of SAV. Other factors such as water clarity also determine at what depth SAV can survive. Based on light attenuation coefficients for the mesohaline salinity regime found in the Sharps Island vicinity, only depths less than 6 feet MLLW are typically appropriate to support SAVs (CBP, 1992).

SAVs are noted as a major factor contributing to the high productivity of the Chesapeake Bay (Dennison et al., 1993). Important SAV in the Chesapeake Bay region (all salinity regimes) include: *Zostera marina, Hydrilla verticillata, Myriophyllum, spicatum, Ruppia maritime, Heteranthera dubi, Vallisneria Americana, Zannichellia palustris, Najas guadalupensis, Potomogeton perfoliatus, Potomogeton pectinatus, Ceraphyllum demersum* and *Elodea canadensis* (CBP, 1992). Of these species, *Zostera* and *Ruppia* species are the only SAV that could potentially be present at Sharps Island.

East of Sharps Island, the Outer Choptank River shorelines had increasing SAV distribution in the early and mid 1990s. However, the data from 1998, 1999, and 2000 indicate that SAV abundance has declined substantially from 1997 (Figure 4-4). The recorded drop in acreage for this particular region in the year 2000 is the most dramatic. Its cause may be from numerous potential sources, including severe algae blooms that impacted much of the Chesapeake Bay mesohaline areas that year (MDNR, 2002a).

Numerous sources that record potential habitat for SAV species in the Chesapeake Bay fail to indicate growth in the Sharps Island vicinity (Orth et al, 1987; 1995; Funderbunk et al, 1991; CBP, 1992). As noted in Orth et al. (1987), aerial photography and MDNR boat surveys at three locations in the vicinity of Sharps Island did not confirm signs of SAV. In addition, previous accounts by Orth *et al.* (1995) using aerial photography did not indicate SAV in the Sharps Island vicinity. Figure 4-5 indicates water depths in the Sharps Island vicinity at depths that provide potential for SAV growth. Although appropriate depths do exist, there are no signs of SAV presence in the area.

Based on these observations and bay-wide decreases in SAV abundance, the occurrence of SAV growth in the Sharps Island vicinity is not likely without the construction of protected shallow water habitat. The Proposed Concept Area designs provide the proper conditions for submerged aquatic vegetation (SAV) growth in protected shallow waters and for tidal marshes. At the present time, water conditions experienced at the mouth of the Choptank River due to water speed and wind action prevent the occurrence of SAV growth. The formation of land at this site through dredged material placement will help reduce wave action in the vicinity of Sharps Island. The reduction of wave action in this area will create potential SAV habitat and may lead to potential SAV growth. Along with wetland and upland habitat, SAV and marsh vegetation growth can provide key habitats for many invertebrates, fish, and waterfowl that use SAV beds, tidal marshes, and shallow shoreline margins as nursery areas and for refuge.

4.6 Birds/Wildlife

Since the island became completely submerged in the 1960s, terrestrial bird habitat has been lost. The only potential location for nesting, foraging, and nesting within the vicinity is the use of Sharps Light. The *Atlas of the Breeding Birds of Maryland and the District of Columbia* (Robbins, 1999) presents distribution maps and data on 199 species of birds that breed in Maryland. Sharps Island falls within or in close proximity of the northwest block of Quadrangle 170. Since the island is submerged, no species currently reside at this location. It is likely that waterfowl and other waterbirds inhabit the area at least occasionally.

4.7 Rare, Threatened and Endangered Species (RTE)

MDNR *Rare, Threatened, and Endangered (RTE) Animals of Maryland* report identifies those native Maryland animals that are among the rarest and most in need of conservation efforts as elements of our State's natural diversity (MDNR, 2001). This report includes species occurring in Maryland that are listed or candidates for listing on the Federal list of Endangered and Threatened Wildlife and Plants, species currently on the State's Threatened and Endangered Species List, and additional species that are considered rare by the Maryland Wildlife and Heritage Division. However, this list is not specific to Sharps Island.

Species identified with State Status designations were determined by the MDNR, in accordance with the Non-game and Endangered Species Conservation Act. Status indicators are noted in the Code of Maryland Regulations (MDNR, 2001). As defined in COMAR (08.03.08), *endangered species* are those whose continued existence as a viable component of the State's flora or fauna is determined to be in jeopardy. *Species in need of conservation* include animal species whose populations are limited or declining in the State such that they may become threatened in the foreseeable future if current trends or conditions persist. *Threatened species* of flora or fauna are those that appear likely, within the foreseeable future, to become endangered in the State. Finally, *endangered extirpated species* are those that were once a viable component of the flora or fauna of the State, but for which no naturally occurring populations are known to exist in the State.

Of the RTE aquatic species on Maryland's list, sea turtle species have the potential to occur in the Sharps Island vicinity (Table 4-3). At the April, 2002 Bay Enhancement Working Group (BEWG) meeting, NMFS stated that the Loggerhead turtle will be negatively impacted, and that the Kemps Ridley turtle may be negatively impacted in the Sharps Island vicinity (Nichols, 2002). The USFWS stated the position that both the Loggerhead and Kemps Ridley turtle species are transients to the area, and that there may be no overall impact on sea turtles (USFWS, 2002).

Since the island is submerged, no RTE avian species currently reside at this location. Waterbirds such as osprey and the bald eagle may potentially inhabit the area at least occasionally.

The US Fish and Wildlife Service (USFWS) was contacted in order to determine potential Federal RTE species at the site. USFWS noted that except for the occasional transient individuals, no federally proposed or listed endangered or threatened species are known to exist at Sharps Island (Appendix B). In addition, MDNR Wildlife and Heritage Service was contacted in order to determine if State records exist for RTE species at Sharps Island. Based on a response from Lori A. Byrne, Environmental Review Specialist, there are no records for Federal or State RTE animals or plants at Sharps Island (Appendix B). However, MDNR had a historical record for a Least Tern (*Sterna antillarum*) colony that used to inhabit Sharps Island. Least terns are currently listed as state threatened in Maryland, and colonies within the Chesapeake Bay Critical Area are protected.

5. Commercial and Recreational Fisheries Resources

5.1 Finfish

The MDNR keeps commercial finfish data for the Chesapeake Bay. Although there are no specific data for Sharps Island, the database provides information for two nearby areas, categorized by NOAA codes 027 (Southern Central Portion of the Chesapeake Bay) and 037 (Choptank River). The locations of these proximate harvest areas as well as other harvest areas in the region are presented in Figure 5-1. Based on the regional data, the Choptank River falls within the low finfish catch range (0 to 61,100 pounds/year), while the South Central Chesapeake Bay area falls within the highest range of fish caught (<765,000 pounds/year) (MDNR, 2002c). Chesapeake Bay commercial landings of finfish from 1995 to 2000 are summarized in Table 5-1.

5.2 Blue Crabs

NMFS has reported blue crab harvesting statistics concerning the Chesapeake Bay. The number of crabs caught in the Chesapeake Bay has been dropping in the past few years. Information obtained from the MDNR database for blue crab caught in the Choptank River and South Central Chesapeake Bay has been maintained since 1990 and is summarized in Table 5-2. In general, the size of the blue crab harvest is steadily declining in the vicinity of Sharps Island. This scenario holds true for most of the Chesapeake Bay. NMFS reports site potential over-fishing as the main problem and increased restrictions as one possible solution.

5.3 Oysters and Soft Shell Clams

The oyster and soft shell clam industries of Maryland have shown decline within the Bay. While soft shell clams and oysters are a valuable resource in the Chesapeake, their decline is a potential result of both over-harvesting and the depletion of stock in general.

Information obtained from MDNR show low harvest numbers for the past ten years (MDNR, 2002b). Oyster disease has limited the harvest numbers for many years. The 2000 harvest data for the two areas of interest (as indicated in Figure 5-1) were:

Choptank River (Area 027):	161,099	lbs	(57,732 bushels)
South Central Chesapeake Bay (Area 037):	49,242	lbs	(29,929 bushels)

Present day oyster bar boundaries partially cover the 1848 historical footprint of Sharps Island. In particular, Natural Oyster Bay (N.O.B.) 14-4 encompasses nearly 3,400 acres of the Island's historical footprint. However, the greater portion of this oyster bar is located to the west of the Island's historical footprint (BBL, 2002). Figure 4-3 indicates the locations of both the historical oyster bars charts and Legal Natural Oyster Bar boundaries around Sharps Island, and indicates that shallow waters around Sharps Island are suitable oyster habitat. Also depicted on this map are locations of where oyster repletion activities have been conducted by MDNR between 1958 and 1999 (MDRN, 2002c).

5.4 Recreational Fishing and Boating

The MDNR Fisheries Service provides recreational sport fishing enthusiasts fishing reports for the Chesapeake Bay and its major tributaries. While the mid Chesapeake Bay supports numerous key recreational fishing locations, none are found within the Proposed Concept Area. MDNR's website provides commonly referred to fishing locations in the Mid Chesapeake Bay (Figure 4-1). Larger and more commonly known recreational fishing locations within 3-4 km of Sharps Island include: the Hook (north), Devil's Hole (northwest), Stone Rock (southeast) and Diamonds (south) [MDNR, 2002c]. While the mid Chesapeake Bay supports numerous key recreational fishing locations, none of the commonly referred to fishing locations (as indicated by the MDNR website) lie directly upon the historical footprint of Sharps Island or the Proposed Concept Area. In comparison to the common fishing locations of the mid Chesapeake Bay indicated in Figure 4-1, site-specific recreational fish grounds in the vicinity of the Sharps Island are presented in Figure 4-2. Based on this map, the Proposed Concept Area designs will directly affect site-specific recreational fish grounds adjacent to the west of the Sharps Island site, as noted in Figure 4-2. In addition, dredge material placement activities may potentially be deleterious to recreational fishing activities approximately 1 mile to the north and to the east of Sharps Island.

The MDNR Fisheries Service provides recreational sport fishing enthusiasts fishing reports for the Chesapeake Bay and its major tributaries. Upon review of Middle Chesapeake Bay fishing reports, it is apparent that many finfish species may potentially be present in the vicinity, including croaker, striped Bass, white perch, catfish, hickory and American Shad. To the date of this report, available information does not indicate that artificial fishing reefs have been established in the footprint of Sharps Island.

Correspondence with Mr. Richard Novotny, Executive Director of the Maryland Saltwater Sportfishermen's Association (Appendix C) suggests that the vicinity of Sharps Island is a traditional fishing area for both charter boat and recreational fishing. According to Mr. Novotny, Atlantic croakers, Norfolk spot, white perch, weakfish (seatrout), and rockfish are caught in or around the Sharps Island area.

5.5 Commercial Fisheries Resources

Correspondence with the Natural Resources Police (Appendix C) indicated that the Sharps Island area provides a valuable resource for commercial fisheries. It was noted that pound net fishermen catch a broad variety of fish in the area (see Figure 4-2). It was also noted that Sharps Island and the immediate vicinity contain productive oyster bars (see Figure 4-3). Drift gill net fishing occurs in the area during the striped bass gill net season. Blue crab harvesting in the area primarily consists of crab pots. Clam fisheries are not prevalent at Sharps Island with the closest being approximately 1.5 miles from the area of interest.

6. Historical Cultural Resources

6.1 History of Sharps Island

Information for this section was complied from various sources, including the Maryland Historical Society (Appendix D), Talbot and Dorchester County Historical Societies, and the Talbot County Library.

6.1.1 Native American Presence at Sharps Island

Maryland Algonquin Indian chiefdoms were present along the Middle Chesapeake Bay during early European colonization. Historically, Choptank Indians were present along the banks of the Choptank River and Sharps Island (Clark and Rountree, 1993). Early Colonists and Native Americans were in close and relatively constant contact with each other on the Eastern Shore of Maryland throughout most of the 17th and early 18th centuries. By 1725, all Choptank Indian towns had been abandoned, with the exception of Locust Neck, an Indian community located in Dorchester County. Locust Neck was the last remaining Indian town to remain along the Eastern Shore until its abolishment by the Maryland government in 1799 (Davidson et al., 1985).

Surviving archeological evidence on the Eastern Shore is fairly meager, and the knowledge of most Indian towns on the Eastern Shore is almost solely based on inferences that have been drawn from documentary resources, such as cartographer accounts (Davidson et al., 1985).

6.1.2 Historical Sharps Island Documentation and Habitation

One of the earliest explorers of the Chesapeake Bay was Captain John Smith. Smith first mapped and described Sharps Island in 1608 during his first full-scale exploration of the Chesapeake Bay (Sanchez-Saavedra, 1975). During the 1600s, the Island is recorded to have had three different owners: William Claiborne, John Bateman, and Peter Sharp, its namesake (Turbyville, 1995). The shallow waters surrounding Sharps Island were first noted in Emmanuel Bowen's rendition of the Chesapeake Bay in his 1747 map "*A New Rendition and Accurate Map of Virginia and Maryland*" (Maryland Historical Society, 1998).

In the early 1800's, a farming and fishing community existed with houses, schools, a post office, and a popular resort hotel. A year after Congress declared war against Great Britain, the enemy seized Sharps Island, Tilghman and Poplar Island (Clark, 1958). By November, the British withdrew from Talbot County waters, but raids continued almost up until news of the ratification of peace negations in early 1815. Between 1850 and 1900, the island lost 80% of its land mass and by the early 1960s, the Island was reduced to a shoal; today it is only marked by Sharps Light, located in the vicinity of the original Island footprint (E2CR, 2002).

6.2 History of Sharps Island Lighthouse

The original Sharps Lighthouse was built on Sharps Island in 1838 (Turbyville, 1995). Due to encroaching waters, this lighthouse was replaced in 1866 with a new hexagonal screw-pile light and relocated 1/3 of a mile off the northern tip of the Island. In February of 1881, ice flows sheared the lighthouse from its piles and carried it for five miles down the Bay (USCG, 2002). In 1882, the lighthouse was replaced with the caisson light presently northwest of the Sharps Island 1848 historical footprint. The current lighthouse was damaged by ice in 1977, and remains on a lean (NPS, 2002). The lighthouse presently stands approximately 54 feet above mean high water. In 1982, Sharps Light was added to the National Register of Historic Places (USCG, 2002).

7. Other Aspects

7.1 Geology

Sharps Island is located on the Atlantic Coastal Plain Physiographic Province, which traverses the majority of the eastern portion of the state. The Coastal Plain extends to the northwest up until the dividing line of the Piedmont, extending from Washington D.C. through Baltimore, Maryland and into northwestern Delaware. The footprint of Sharps Island lies 1 mile due west of a noted fault line which divides the Choptank River and extends into the Chesapeake Bay (Maryland Geological Survey, 1968).

7.2 Groundwater and Aquifers

Sharps Island lies above the Piney Point and Cheswold aquifers in Eastern Maryland. Of these two aquifers, it is the Piney Point aquifer that is used as a source of water in southern and eastern Maryland.

The Piney Point formation is part of a sequence of geologic formations that occur in the Atlantic Coastal Plain Physiographic Province. This aquifer is a sand layer composed of fine to very coarse sand varying from a few feet to more than 120 feet in thickness. The Piney Point Aquifer has a depth range between 80 to 550 feet below sea level (Williams, 1979). Below Sharps Island, the top of the Piney Point Aquifer is approximately 175 feet below mean sea level (Williams, 1979). In the vicinity of Sharps Island, the thickness of the confining layer overlying the Piney Point aquifer has been estimated to be approximately 50 feet (Williams, 1979).

The Piney Point aquifer does not outcrop on land or water. This separation between the Piney Point aquifer and the land and Chesapeake Bay waters above, known as the upper confining layer, is comprised of clay, silt, clayey sand, and thin sand stringers (Williams, 1976). Because there is no connect to precipitation, the water table aquifer, or the Chesapeake Bay Basin, the Piney Point aquifer must receive its recharge indirectly from the Cheswold and other aquifers. Recharging occurs when the head differential between the Piney Point aquifer and the Cheswold Aquifer is great enough to induce water to leak through the semiconfining material between these two aquifers (Williams, 1979). Current records depict declining water levels in these and other aquifers across the northeastern United States.

7.3 Aesthetics and Noise

Sharps Island is located approximately 4 miles south of Tilghman Island (Talbot County) and 4 miles west of Cook Point (Dorchester County) at the mouth of the Choptank River. In comparison to Poplar Island, Sharps Island is approximately 1.3 miles further from land, and would therefore have a lesser problem regarding on-site construction lighting issues during the process of dredged material placement. Therefore, due to its given location, this site does not pose a direct aesthetic or noise issue.

7.4 Unexploded Ordnance (UXO)

Throughout the Chesapeake Bay, sediment may potentially contain unexploded ordnance (UXO) as the result of historical military and naval activities. Based on military documentation, UXO and munitions resulting from testing and training activities may be encountered in the Sharps Island vicinity. In 1943, the Federal Government acquired approximately 6.5 acres to create Sharps Island Air Force Range. Based on the estimated size of Sharps Island in 1943, it is estimated that the acquired acreage was the entire remaining exposed land.

The Sharps Island Air Force Range was primarily used by military personnel from Bolling Field, Washington, D.C. as a remote location for bombardment and machine gun training.

Sharps Island Air Force Range was transferred from the Department of the Army to the Department of the Navy by memo in 1957. In 1967, the island was designated as disposable by the Department of the Navy. A final Record of audit was completed in 1967, when the accountability of the land records was transferred to the Department of the Navy. Based on a military document dated December 16th, 1986, and signed by R.E.Abbott (COL, CE Commanding), the 6.5 acre historical footprint of Sharps Island acquired by the Federal Government in 1943 is presently under the authority of the Department of Defense (Appendix E).

7.5 Navigation

Sharps Island is approximately 4.2 miles northeast of a recreational channel, located near Blackwalnut Point. A natural deep water channel, with a depth of 60 feet, is located 3.5 miles to the west of Sharps Island. In order to commence dredged material placement at the site, a local access channel would have to be dredged to reach the proposed concept area location.

The Sharps Island Light (US Coast Guard Reference #82002821) is located in the vicinity of Sharps Island. Originally constructed in 1838, the lighthouse remains as an aid to navigation in the southern Chesapeake Bay. The lighthouse is currently in use today. The lighthouse is equipped with a foghorn, and a flashing white light with one red sector that can be seen from a distance of 9 miles (USCG, 2002). The proximity of Sharps Island to other navigational buoys in the mid Chesapeake Bay and Choptank River are presented in Figure 4-1.

8. Potential Impacts

8.1 Water and Sediment Quality

As sediment from the project settles to the bottom of the Bay, they can smother bottom-dwelling plants and animals, such as oysters and clams. Sediments suspended in the water column cause the water to become cloudy, or turbid, decreasing the light available for underwater Bay grasses (CBP, 2002). However, it is assumed that longer term water clarity would not be affected by the proposed activities and might be improved if tidal or subtidal vegetation are established in the area.

8.2 Biological Resources

The proposed restoration of protected shallow waters, tidal marshes and wetlands will provide key habitats for many invertebrates, fish and waterfowl in various life stages. Benthic invertebrates, fish species and birds will benefit from the regeneration of this environment. The Proposed Concept Areas would convert shallow water habitat into wetland and upland habitat. Based on the five proposed concept areas, approximately 535 to 1,130 acres of tidal wetlands may be created.

During proposed dredged material placement, a risk of impact to Bluefish, Summer flounder, Spanish Mackerel and Red Drum EFH species are a concern for the Sharps Island area (Nichols, 2002). In addition, the Loggerhead turtle and Kemps Ridley sea turtle species may be impacted in this area. It should be noted that marine turtles are transients in open water habitat in this portion of the Chesapeake Bay, suggesting that negative impacts may be minimal or may not occur.

Upon completion of this project, the creation of wetland and upland habitats will inevitably lead to a resurgence of species to the area. Sea turtle species found in the Bay may utilize the created wetland habitats and shoals. Protected waters may also lead to SAV growth in the area. Potential SAV HAPC in this area would support both benthic invertebrates and fish species. Avian species will certainly return to the created wetland and upland habitat, as the island was a noted location for avian species including the State-threatened Least Tern (Hanks, 1975; Appendix B). Depending upon circumstances, the Island may or may not become home to mammalian species found in the Bay area, such as raccoon, muskrat, and striped skunk (CBP, 1998).

8.3 Commercial and Recreational Fisheries Resources

Recreational fishing and oyster resources are found in the Sharps Island vicinity. Based on recreational fishing grounds bordering the Proposed Concept Area (Figure 4-2), and the location of oyster restoration sites and legal natural oyster bar boundaries within the Proposed Concept Area (Figure 4-3), there will be a negative impact upon these activities.

8.4 Historical and Cultural Resources

Due to the current submerged condition of Sharps Island, there are no present historical and cultural concerns to note. It should be noted that none of the proposed activities pose an impact upon the Sharps Island lighthouse.

9. Conclusions

The submerged footprint of Sharps Island is all that remains since the island's disappearance in the early 1960s (Hanks, 1975). Currently, the island footprint acts a shallow water habitat for aquatic organisms. Although the aquatic conditions in the Sharps Island vicinity are variable depending on season, time of day, tide, and weather, benthic and fish presently inhabit the area.

Of the RTE aquatic species on Maryland's list, the Loggerhead turtle and Kemps Ridley turtle species have the potential to occur in the Sharps Island vicinity (Table 4-3). Therefore, a risk of adverse impacts to these two sea turtle species exists. It should be noted that marine turtles are transients in open water habitat in this portion of the Chesapeake Bay, suggesting that negative impacts may be minimal or may not occur. Ultimately, impacts to sea turtles at Sharps Island will need to be decided by coordination with NMFS. In addition, official consultation with the NMFS regarding EFH and HAPC is recommended before any activity would begin in the area.

While no RTE bird species currently reside at this submerged location, waterbirds such as osprey and the bald eagle may potentially inhabit the area at least occasionally. In the past, Sharps Island was home to a Least Tern colony. Least terns are currently listed as state threatened in Maryland, and colonies within the Chesapeake Bay Critical Area are protected.

Based on the potential for UXOs at Sharps Island and its immediate surroundings, additional consultation with the Department of Defense is recommended prior to any further on-site investigations.

The proposed concept area designs would create approximately 1,070 to 2,260 acres of island wetland and upland habitat at the site (BBL, 2002). These designs should provide the proper conditions for submerged aquatic vegetation growth in protected shallow waters and tidal marshes. The potential for SAV growth can provide key habitats for many invertebrates, fish and waterfowl that use SAV beds, tidal marshes and shallow shoreline margins as nursery areas and for refuge. Predators, including blue crabs, spot, striped bass, waterfowl, waterbirds and raptors, forage for food in this type of environment. Bird species populations will use the island for nesting and residence. Over time, upland areas have the potential to support mammalian species.

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Tables

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Table 4-1. Seasonal frequency and life stage presence of Essential Fish Habitat (EFH) species of concern for Sharps Island.

EFH Species	Potential Life Stage Present at Sharps Island	Potential Seasonal Distribution at Sharp's Island
Bluefish	juvenile, adult	Spring, Summer, Fall
Red drum	juvenile, adult	Fall
Spanish mackerel	juvenile, adult	Spring, Summer, Fall (Occasional)
Summer flounder	juvenile, adult	Spring, Summer, Fall

Notes:

Source: NMFS, 2002.

Table 4-2. Finfish species that occur or have the potential to occur in the mid Chesapeake Bay

Common Name	Scientific Name
Alewife	*Alosa pseudoharengus*
American eel	*Anguilla rostrata*
Atlantic croaker	*Micropogonias undulates*
Atlantic menhaden	*Brevoortia tyrannus*
Atlantic needlefish	*Strongylura marina*
Atlantic silverside	*Menidia menidia*
Atlantic sturgeon	*Acipenser oxyrhynchus*
Banded killifish	*Fundulus diaphanus*
Bay anchovy	*Anchoa mitchilli*
Black drum	*Pogonias cromis*
Black sea bass	*Centropristis striata*
Blueback herring	*Alosa aestivalis*
Bluefish	*Pomatomus saltatrix*
Bluegill	*Lepomis macrochirus*
Bluntnose stingray	*Dasyatis say*
Bull shark	*Carcharhinus leucas*
Butterfish	*Peprilus triacanthus*
Clearnose skate	*Raja eglanteria*
Cobia	*Rachycentron canadum*
Cownose ray	*Rhinoptera bonasus*
Dusky pipefish	*Syngnathus floridae*
Feather blenny	*Hypsoblennius hentz*
Fourspine stickleback	*Apeltes quadracus*
Gizzard shad	*Dorosoma cepedianum*
Green goby	*Microgobius thalassinus*
Halfbeak	*Hyporhamphus unifasciatus*
Harvestfish	*Peprilus alepidotus*
Hickory shad	*Alosa mediocris*
Hogchoker	*Trinectes maculatus*
Inland silverside	*Menidia beryllina*
Inshore lizardfish	*Synodus foetens*
Lined seahorse	*Hippocampus erectus*
Mosquitofish	*Gambusia holbrooki*
Mummichog	*Fundus heteroclitus*
Naked goby	*Gobiosoma bosc*
Northern pipefish	*Syngnathus fuscus*
Northern puffer	*Sphoeroides maculatus*
Northern searobin	*Prinonotus carolinus*
Northern stargazer	*Astrocopus guttatus*
Orange filefish	*Aluterus schoepfi*
Oyster toadfish	*Opsanus tau*
Pumpkinseed	*Lepomis gibbosus*

Table 4-2. Finfish species that occur or have the potential to occur in the mid Chesapeake Bay

Common Name	Scientific Name
Rainwater killifish	*Lucania parva*
Red drum	*Sciaenops ocellatus*
Red hake	*Urophycis chuss*
Rough silverside	*Membras martinica*
Sandbar shark	*Carcharhinus plumbeus*
Seaboard goby	*Gobiosoma ginsburgi*
Sheepshead minnow	*Cyprinodon variegatus*
Shortnose sturgeon	*Acipenser brevirostrum*
Silver perch	*Bairdiella chrysoura*
Skilletfish	*Gobiesox strumosus*
Smooth dogfish	*Mustelus canis*
Southern stingray	*Dasyatis americana*
Spiny dogfish	*Squalus acanthias*
Spot	*Leiostomus xanthurus*
Spotted hake	*Urophycis regia*
Spotted seatrout	*Cynoscion nebulosus*
Striped bass	*Morone saxatilis*
Striped blenny	*Chasmodes bosquianus*
Striped burrfish	*Chilomycterus schoepfi*
Striped killifish	*Fundulus majalis*
Striped mullet	*Mugil cephalus*
Summer flounder	*Paralichthys dentatus*
Threespine stickleback	*Gasterosteus aculeatus*
Weakfish	*Cynoscion regalis*
White mullet	*Mugil curema*
White perch	*Morone americana*
Windowpane	*Scophthalmus aquosus*
Winter flounder	*Pleuronectes americanus*
Yellow perch	*Perca flavescens*

Notes:

Source: CBP, 1998.

Table 4-3. Rare, Threatened and Endangered (RTE) species found in Maryland waters.

Scientific Name	Common Name	State Status
PLANARIANS		
Procotyla typhlops	A planarian	E
Sphalloplana hoffmasteri	Hoffmaster's cave planarian	E
MOLLUSKS		
Alasmidonta heterodon	Dwarf wedge mussel	E
Alasmidonta undulata	Triangle floater	E
Alasmidonta varicosa	Brook floater	E
Fontigens orolibas	Blue ridge spring snail	E
Glyphyalinia raderi	Rader's snail	X
Hendersonia occulta	Cherrydrop snail	I
Lampsilis cariosa	Yellow lampmussel	X
Lasmigona subviridis	Green floater	E
CRUSTACEANS		
Caecidotea franzi	Franz's cave isopod	E
Crangonyx dearolfi	Dearolf's cave amphipod	E
Stygobromus allegheniensis	Allegheny cave amphipod	I
Stygobromus biggersi	Biggers' cave amphipod	E
Stygobromus emarginatus	Greenbrier cave amphipod	E
Stygobromus franzi	Franz's cave amphipod	I
Stygobromus gracilipes	Shenandoah cave amphipod	E
FISHES		
Acipenser brevirostrum	Shortnose sturgeon	E
Catostomus catostomus	Longnose sucker	E
Cottus cognatus	Slimy sculpin	T
Enneacanthus chaetodon	Blackbanded sunfish	I
Etheostoma sellare	Maryland darter	E
Etheostoma vitreum	Glassy darter	E
Noturus flavus	Stonecat	I
Pararhinichthys bowersi	Cheat minnow	X
Percina notogramma	Stripeback darter	E
Percopsis omiscomaycus	Trout-perch	X
REPTILES		
Caretta caretta	Atlantic loggerhead turtle	T
Chelonia mydas	Atlantic green turtle	T
Dermochelys coriacea	Atlantic leatherback turtle	E
Eretmochelys imbricata	Atlantic hawksbill turtle	E
Lepidochelys kempii	Atlantic ridley turtle	E

Scientific Name	Common Name	State Status
BIRDS		
Accipiter gentilis	Northern goshawk	E
Aimophila aestivalis	Bachman's sparrow	X
Ammodramus henslowii	Henslow's sparrow	T
Asio flammeus	Short-eared owl	I
Bartramia longicauda	Upland sandpiper	E
Botaurus lentiginosus	American bittern	I
Campephilus principalis	Ivory-billed woodpecker	X
Charadrius melodus	Piping plover	E
Charadrius wilsonia	Wilson's plover	E
Chondestes grammacus	Lark sparrow	X
Cistothorus platensis	Sedge wren	T
Contopus cooperi	Olive-sided flycatcher	E
Dendroica fusca	Blackburnian warbler	T
Empidonax alnorum	Alder flycatcher	I
Falco peregrinus	Peregrine falcon	E
Gallinula chloropus	Common moorhen	I
Haliaeetus leucocephalus	Bald eagle	T
Ixobrychus exilis	Least bittern	I
Lanius ludovicianus	Loggerhead shrike	E
Laterallus jamaicensis	Black rail	I
Limnothlypis swainsonii	Swainson's warbler	E
Numenius borealis	Eskimo curlew	X
Oporornis philadelphia	Mourning warbler	E
Picoides borealis	Red-cockaded woodpecker	X
Rynchops niger	Black skimmer	T
Sterna antillarum	Least tern	T
Sterna dougallii	Roseate tern	X
Sterna maxima	Royal tern	E
Sterna nilotica	Gull-billed tern	T
Vermivora ruficapilla	Nashville warbler	I

Definitions for the above categories have been taken from Code of Maryland Regulations (COMAR) 08.03.08:

E - Endangered; a species whose continued existence as a viable component of the State's flora or fauna is determined to be in jeopardy.

I - In Need of Conservation; an animal species whose population is limited or declining in the State such that it may become threatened in the foreseeable future if current trends or conditions persist.

T - Threatened; a species of flora or fauna which appears likely, within the foreseeable future, to become endangered in the State.

X - Endangered Extirpated; a species that was once a viable component of the flora or fauna of the State, but for which no naturally occurring populations are known to exist in the State.

Source: Maryland Wildlife and Heritage Division, 2001.

Table 5-1. Chesapeake Bay Commercial Fish Data 1990-1999.

Species	1994 Pounds	1994 Dollars	1995 Pounds	1995 Dollars	1996 Pounds	1996 Dollars	1997 Pounds	1997 Dollars	1998 Pounds	1998 Dollars	1999 Pounds	1999 Dollars	2000 Pounds	2000 Dollars
BASS, STRIPED	977,182	$1,696,351	1,314,444	$2,000,350	1,594,192	$2,606,511	2,485,714	$3,412,371	2,883,360	$3,716,949	2,430,310	$3,886,182	2,705,143	$4,215,711
BLUEFISH	164,822	$43,116	107,862	$38,568	0	$0	0	$0	185,359	$49,200	145,298	$44,844	84,250	$23,424
BUTTERFISH	17,853	$8,733	14,741	$6,807	0	$0	0	$0	0	$0	0	$0	0	$0
COBIA	29	$14	139	$181	0	$0	0	$0	0	$0	0	$0	0	$0
CROAKER, ATLANTIC	218,744	$129,508	549,716	$288,575	810,435	$291,324	1,455,707	$497,880	1,375,646	$453,055	1,584,412	$482,034	1,501,655	$569,224
DRUM, BLACK	8,956	$4,464	3,494	$48	0	$0	99,950	$11,405	894	$925	2,785	$614	2,090	$430
DRUM, RED	1,152	$499	6	$1	0	$0	24	$14	419	$280	707	$522	877	$620
FLOUNDER, SUMMER	180,429	$308,849	175,263	$321,847	0	$0	0	$0	0	$0	0	$0	0	$0
FLOUNDER, WINTER	3,391	$5,479	4,937	$6,622	0	$0	1,854	$2,038	4,391	$4,929	2,725	$2,999	3,690	$8,890
MACKEREL, KING AND CERO	28	$35	175	$22	0	$0	187	$231	13,204	$14,217	183	$417	246	$315
MACKEREL, SPANISH	3,363	$1,065	3,089	$1,423	0	$0	3,033	$2,548	4,463,884	$426,307	21,604	$20,757	26,607	$26,532
MENHADEN, ATLANTIC	3,512,417	$891,430	0	$0	1,367,120	$800,554	4,898,967	$481,060	0	$0	5,721,212	$463,483	4,870,835	$522,909
PERCH, WHITE	974,652	$762,835	1,223,919	$950,032	56,031	$40,988	2,058,330	$884,786	1,456,531	$884,453	1,516,148	$762,790	1,921,423	$940,789
PERCH, YELLOW	71,421	$69,682	83,636	$67,405	3,622	$3,302	101,522	$141,050	136,691	$186,264	195,150	$328,567	105,601	$175,228
TAUTOG	1,718	$918	4,416	$3,325	132,795	$102,777	7,663	$8,095	5,682	$6,492	6,489	$7,909	3,896	$5,070
WEAKFISH	140,907	$130,708	69,417	$60,400	0	$0	192,634	$83,711	244,467	$113,420	223,455	$130,027	208,315	$112,956

Table 5-2. Chesapeake Bay Commercial Blue Crab Data 1990-1999.

NOAA Code 27 - South Central Chesapeake Bay	
Year	**Pounds**
1990	8,037,498
1991	8,069,789
1992	4,531,818
1993	12,063,067
1994	8,923,357
1995	8,038,718
1996	6,663,188
1997	9,278,642
1998	6,027,585
1999	6,629,975
Yearly Average:	***7,826,364***
Decade Total:	***78,263,637***

NOAA Code 37 - Choptank River	
Year	**Pounds**
1990	5,549,404
1991	6,803,578
1992	3,239,950
1993	6,989,346
1994	6,007,893
1995	4,480,527
1996	3,356,812
1997	3,935,082
1998	2,052,141
1999	3,346,406
Yearly Average:	***4,576,114***
Decade Total:	***45,761,139***

Figures

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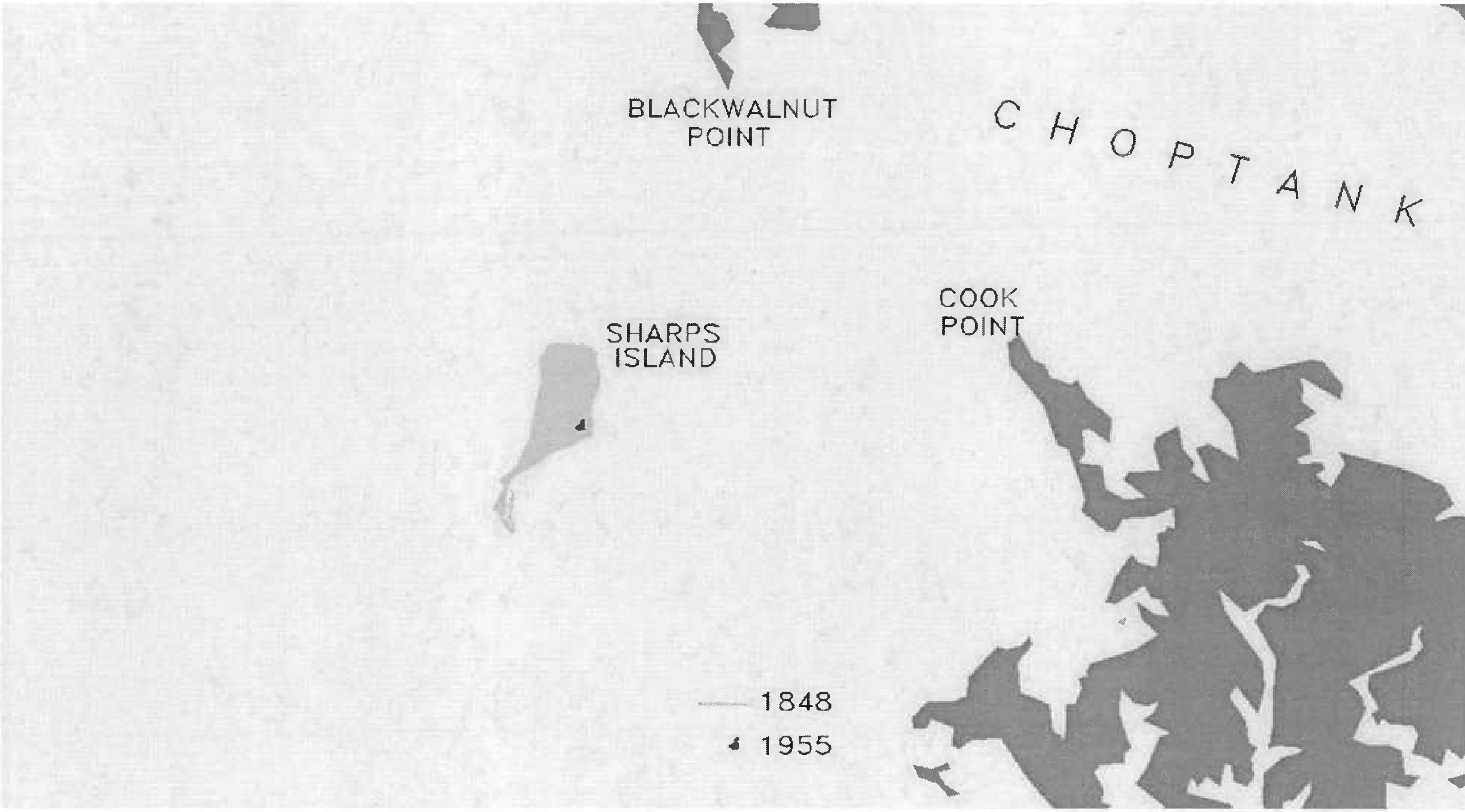

(Source: AMA, 2002; USGS, 2002)

Draft Reconnaissance Study of Environmental Conditions at Sharps Island

Location of Sharps Island in Relation to Blackwalnut Point and Cook Point. Historical Footprint Changes: 1848 and 1955.

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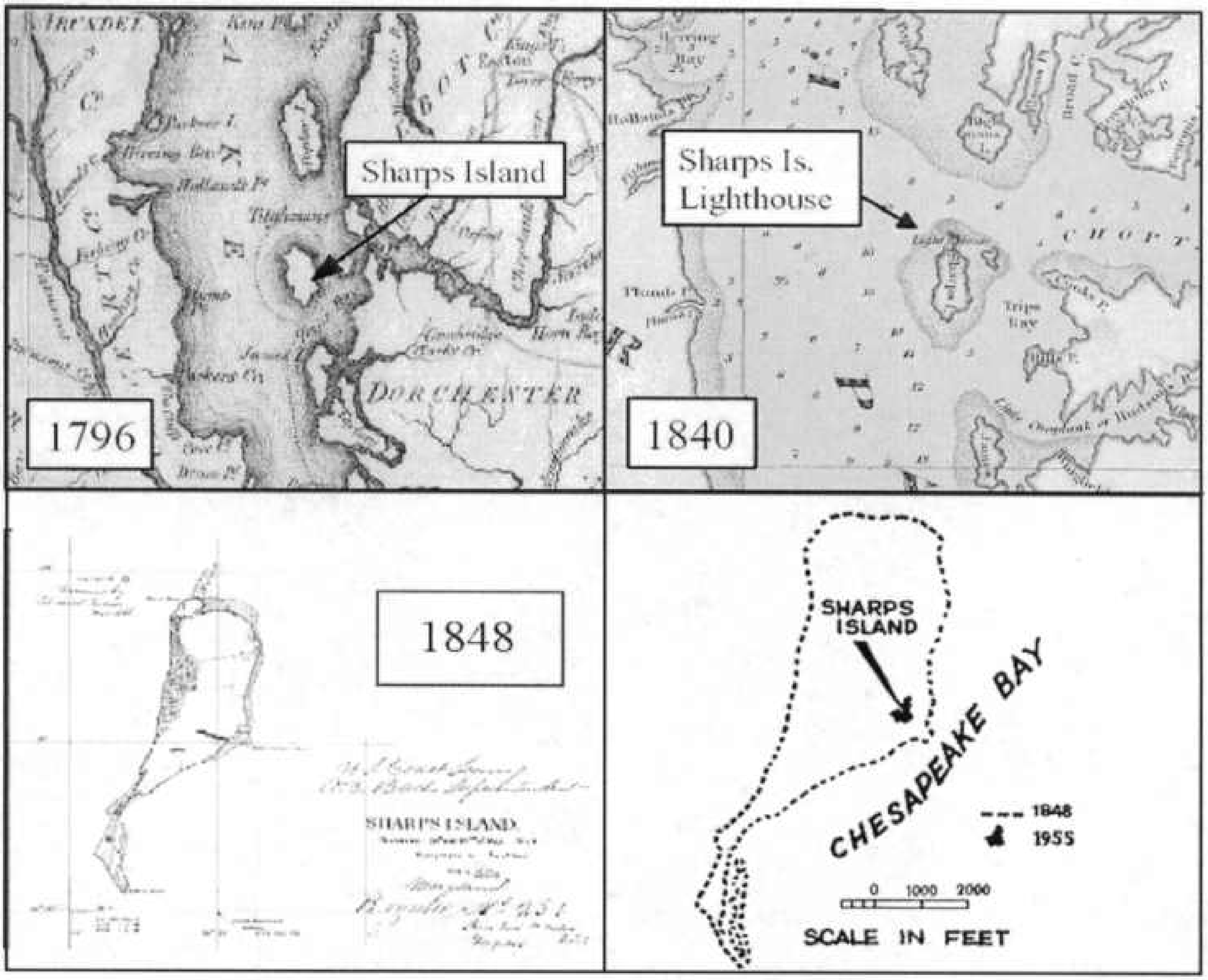
FIGURE 1-1



(Source: Maryland Historical Society, 1998; U.S Coast Survey, 1848, Hacks, 1975).

Draft Reconnaissance Study of Environmental Conditions at Sharps Island

Historical Record of Sharps Island Footprint

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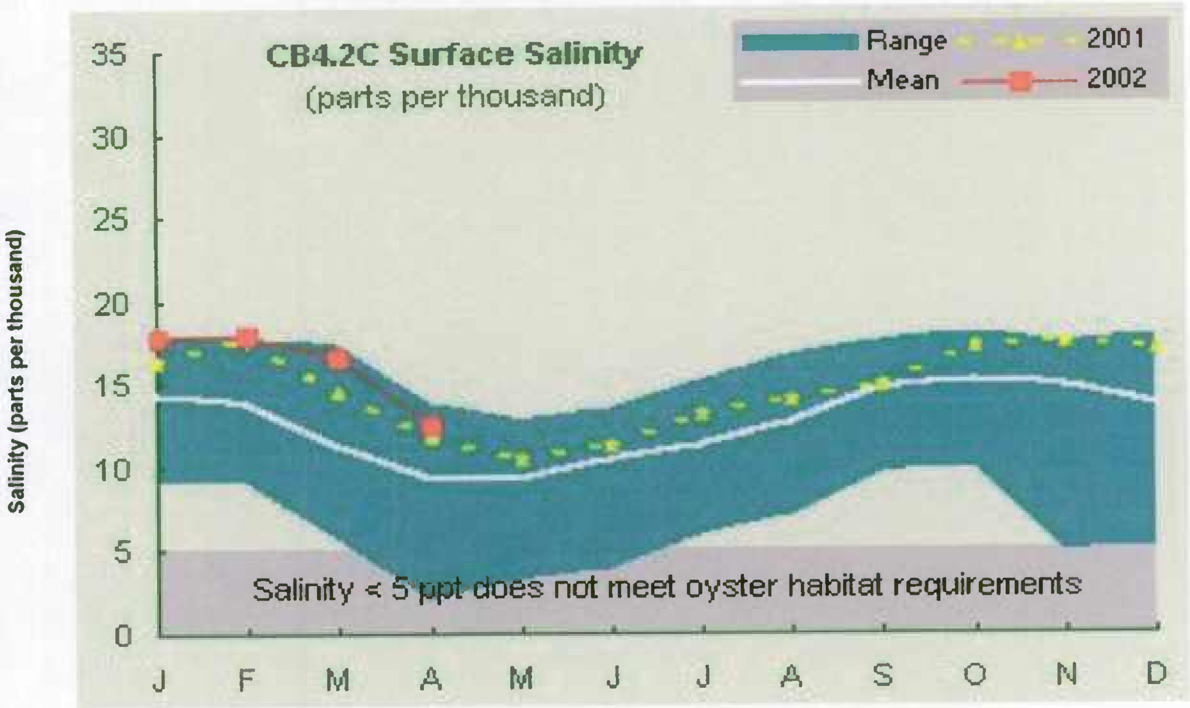
FIGURE 1-2



(Source: Chesapeake Bay Program, 2002).

Draft Reconnaissance Study of Environmental Conditions at Sharps Island

Surface Water Temperature (degrees Celsius) and Salinity (parts per thousand): Mid-Chesapeake Bay Station CB 4.2C.

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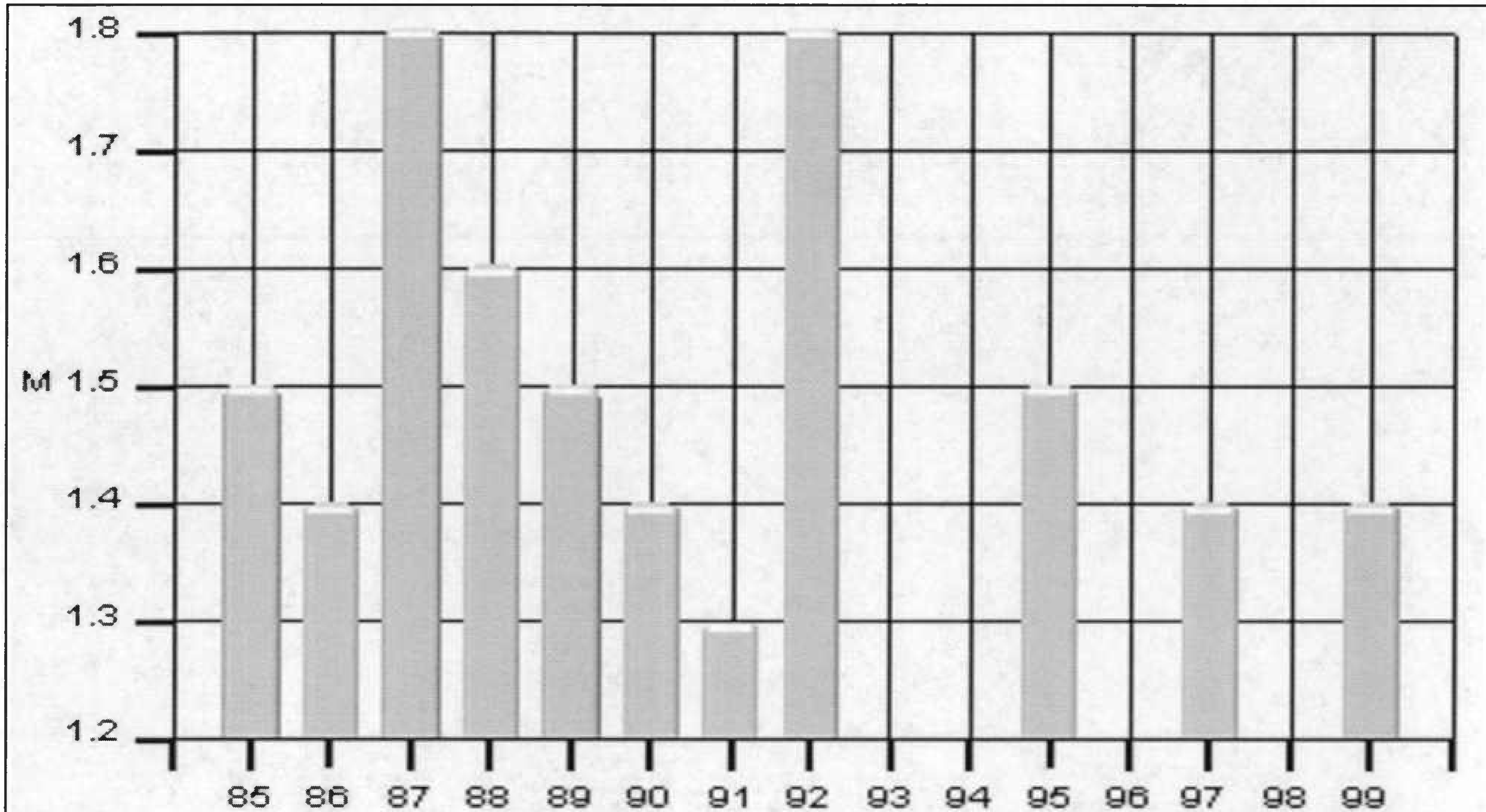
FIGURE 3-1



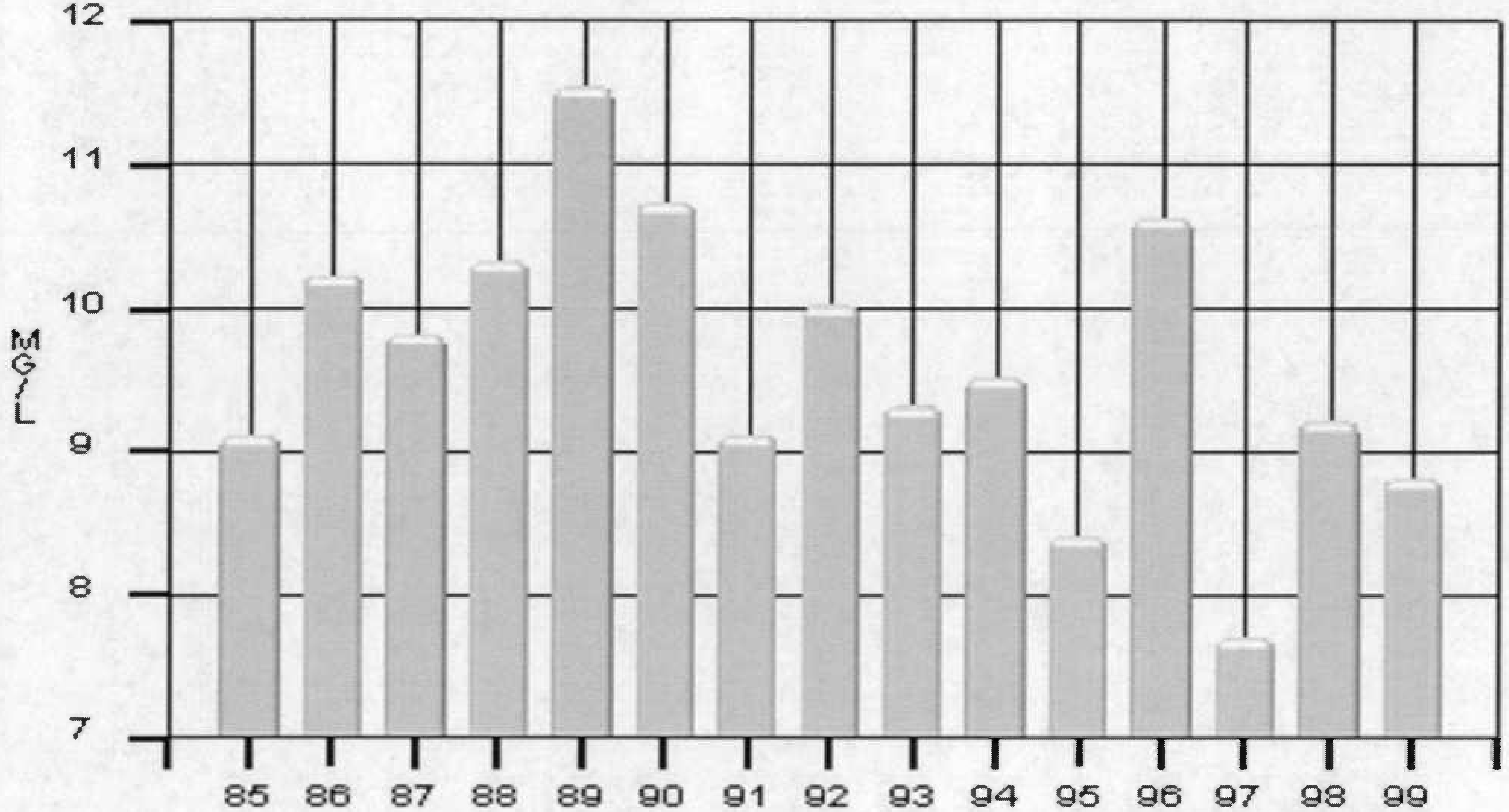
Draft Reconnaissance Study of Environmental Conditions at Sharps Island

Water Clarity (Secchi depth in meters) - Summary of Annual Readings for Site EE2.1 1985-1999.

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 3-2

(Source: Chesapeake Bay Program, 2002).



Draft Reconnaissance Study of Environmental Conditions at Sharps Island

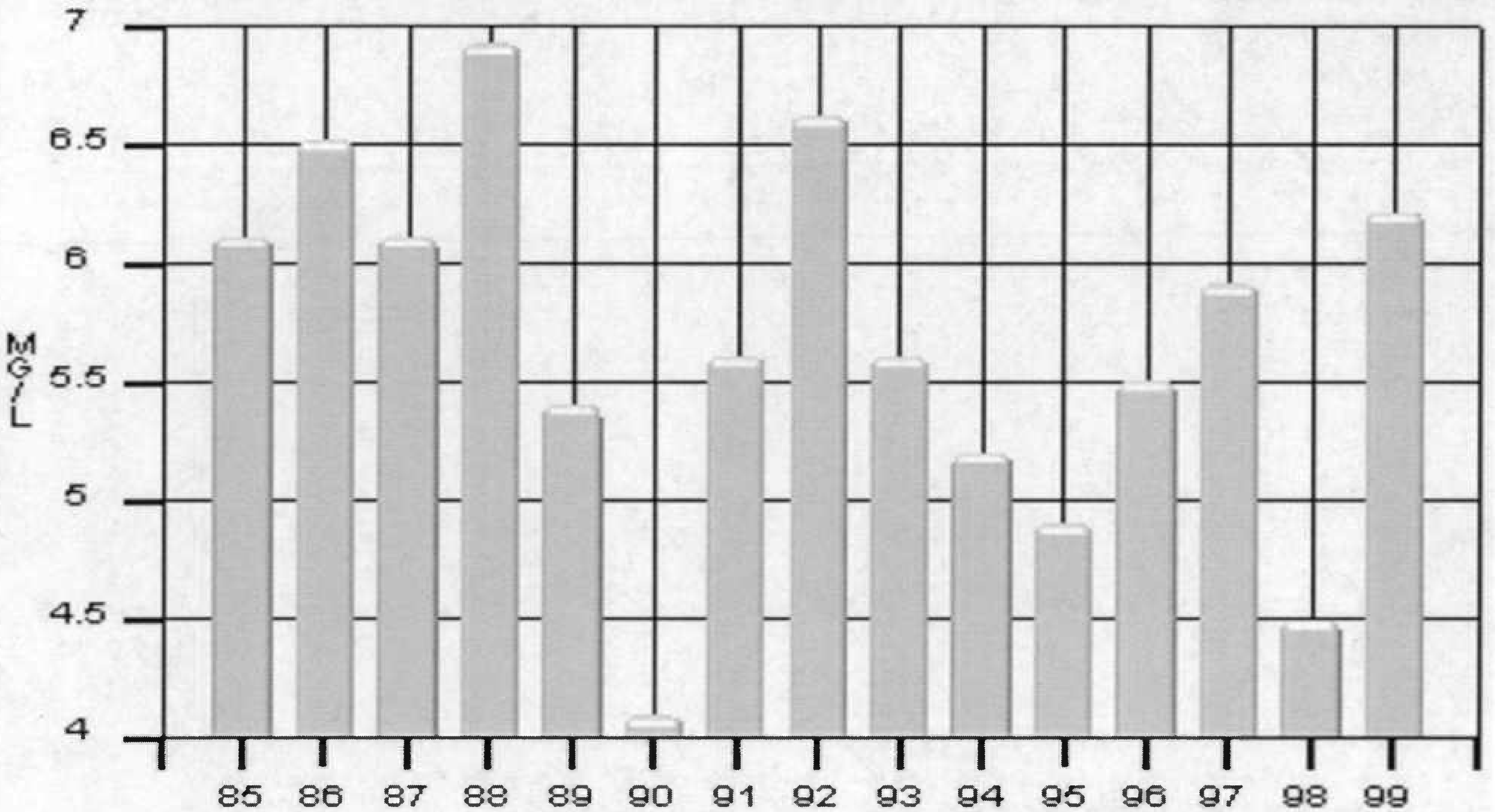
Spring Dissolved Oxygen (mg/L): Summary of Annual Readings for Site EE2.1 1985-1999.

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 3-3

(Source: Chesapeake Bay Program, 2002).

ms_03522002figs.xls_3-3_9/27/2002



(Source: Chesapeake Bay Program, 2002).

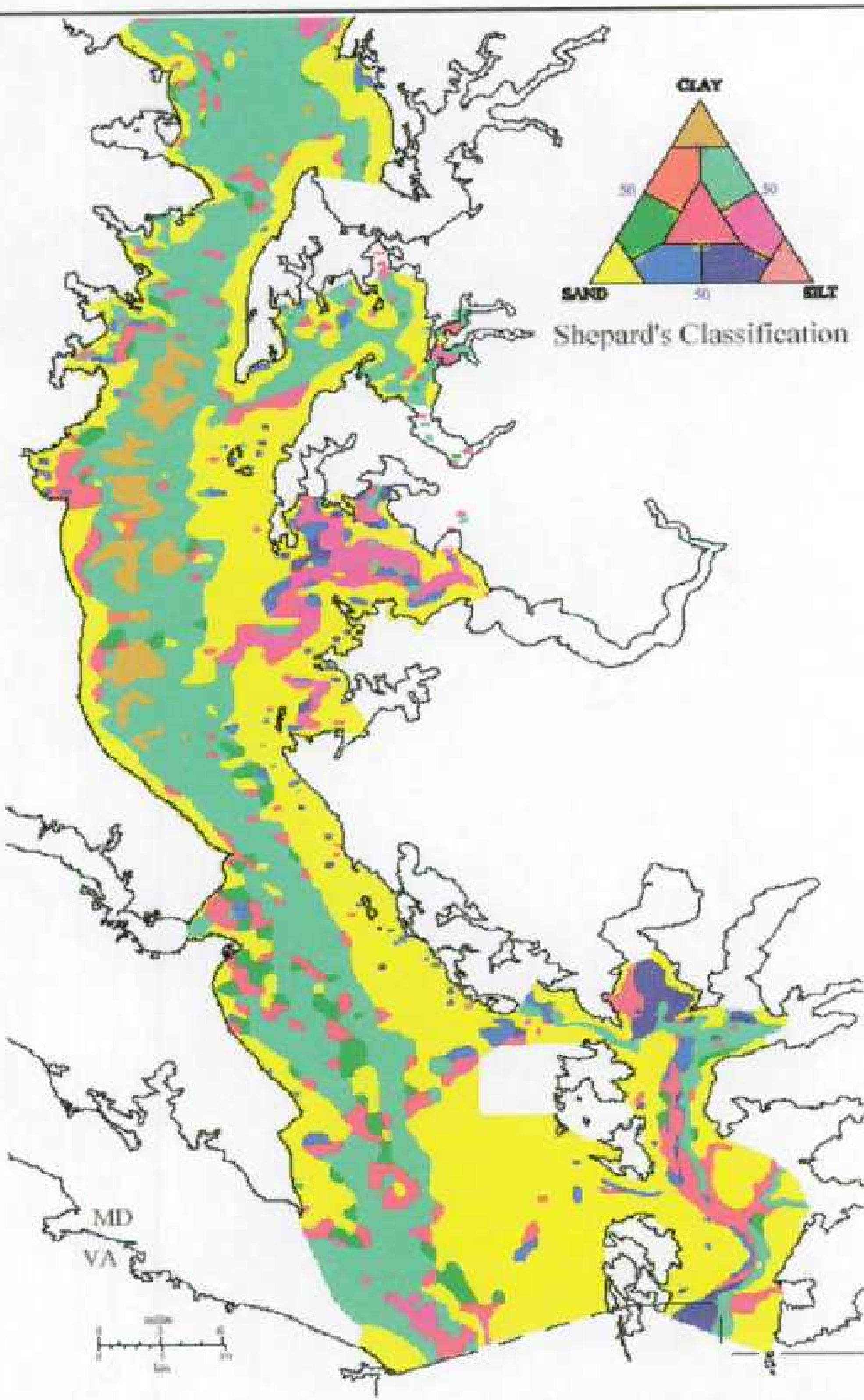
Draft Reconnaissance Study of Environmental Conditions at Sharps Island

Summer Dissolved Oxygen (mg/L): Summary of Annual Readings for Site EE2.1 1985-1999.

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 3-4

ms_03522002figs.xls_3-4_9/27/2002



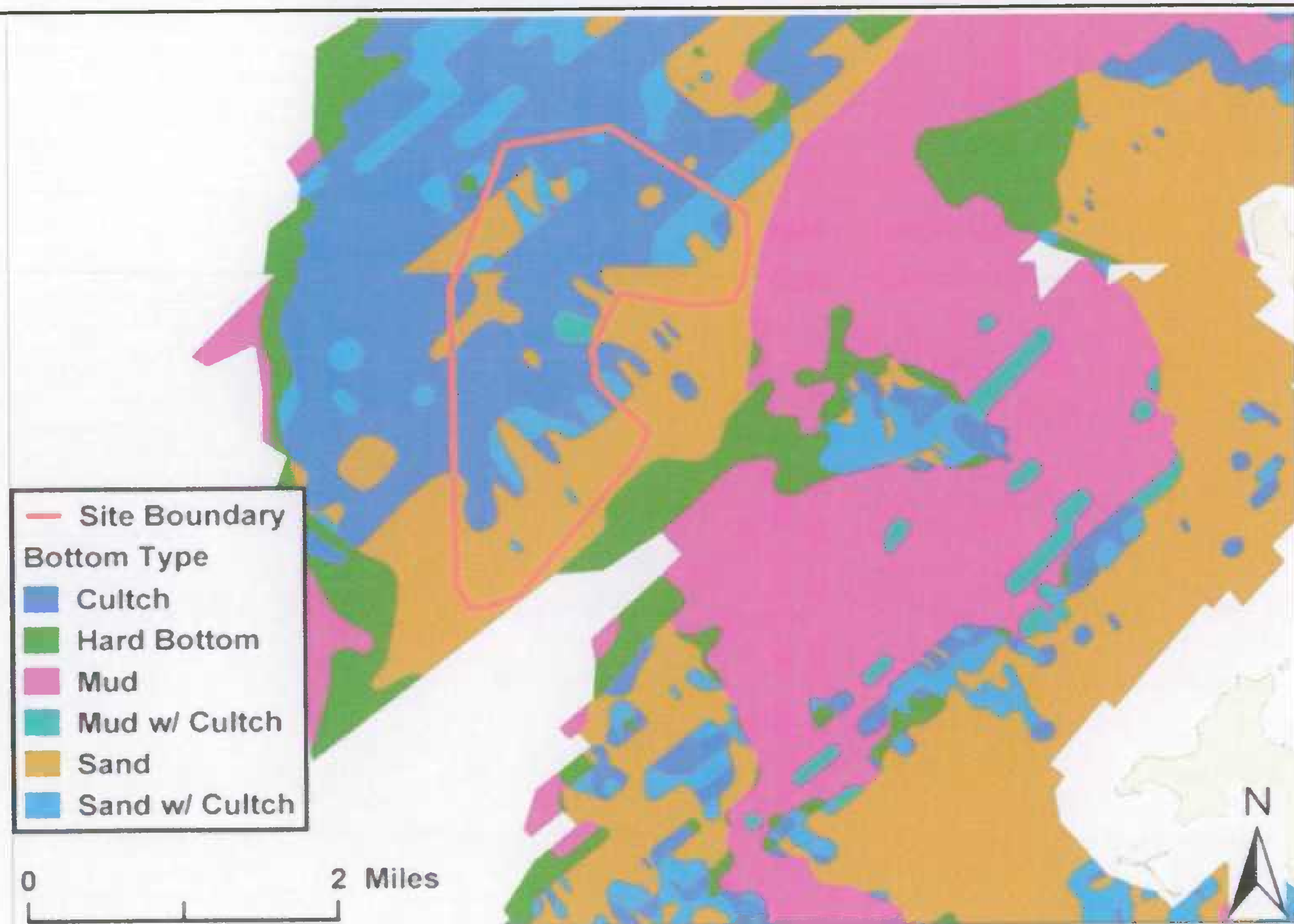
Draft Reconnaissance Study of Environmental Conditions at Sharps Island

Sediment Map for the Upper and Middle Chesapeake Bay

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 3-5

(Source: Maryland Geologic Survey, 2002).



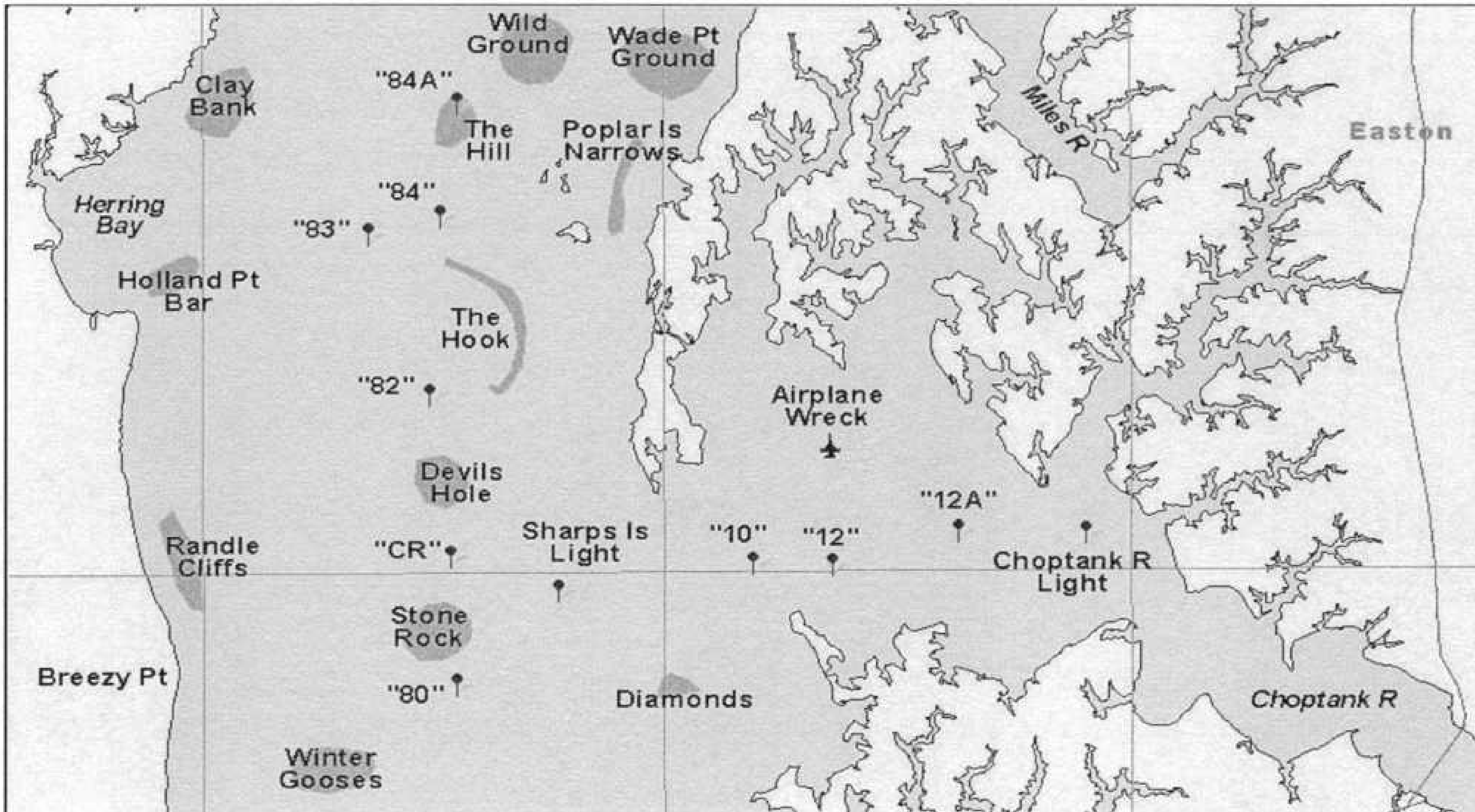
Draft Reconnaissance Study of Environmental Conditions at Sharps Island

Bottom Composition In the Vicinity of Sharps Island.

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 3-6

(Source: MDNR, 2002c).



(Source: MDNR Fisheries Service. 2002)

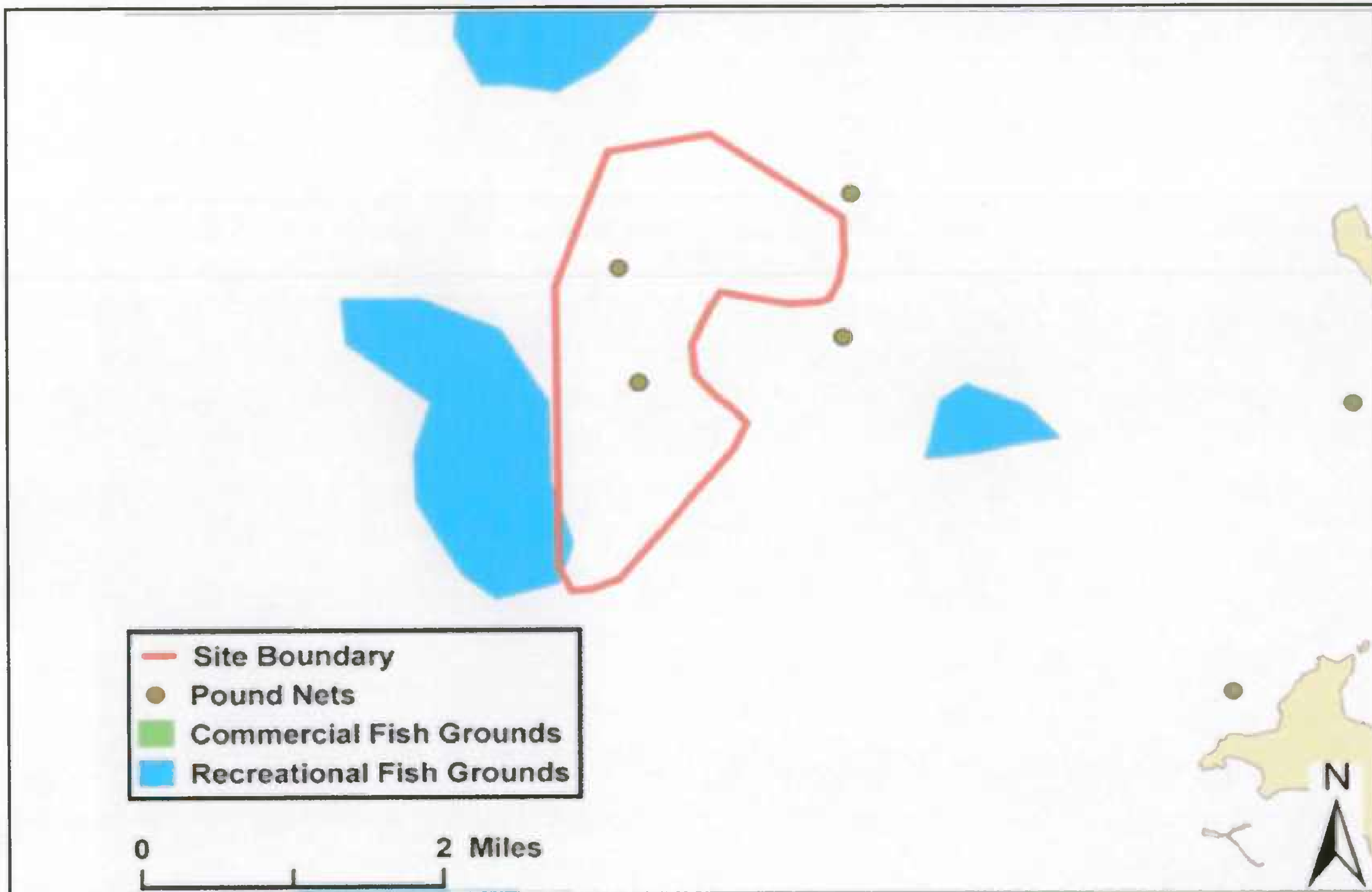
Draft Reconnaissance Study of Environmental Conditions at Sharps Island

Commonly referred to fishing locations in the Mid Chesapeake Bay in relation to shoreline and navigational buoys.

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 4-1

ms_03522002figs.xls_4-1_9/27/2002



Draft Reconnaissance Study of Environmental Conditions at Sharps Island

Commercial and Recreational Fishing in the Vicinity of Sharps Island

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 4-2

(Source: MDNR, 2002c).

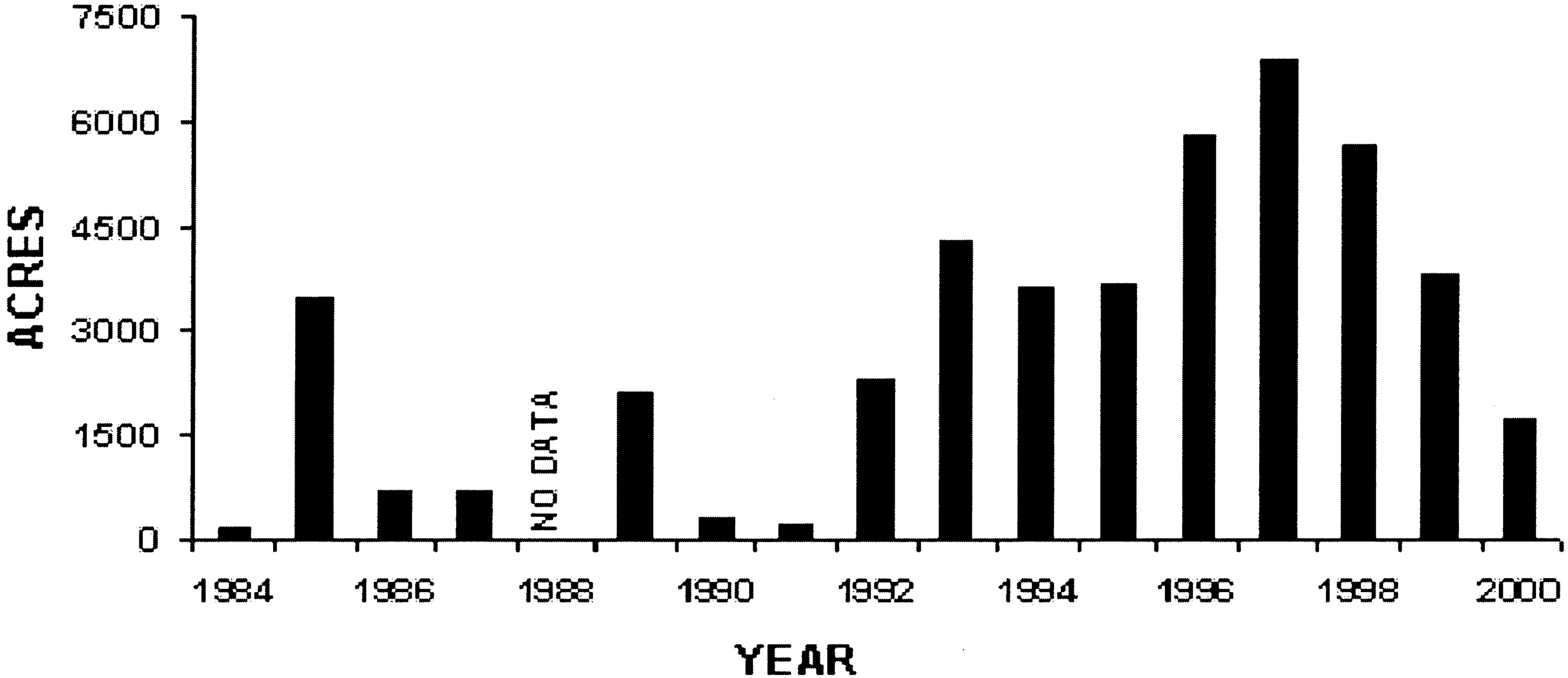
(Source: MDNR, 2002c).

Draft Reconnaissance Study of Environmental Conditions at Sharps Island

Historic and Present Oyster Bar Boundaries, Including Oyster Restoration Sites

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 4-3



(Source: MDNR, 2002a)

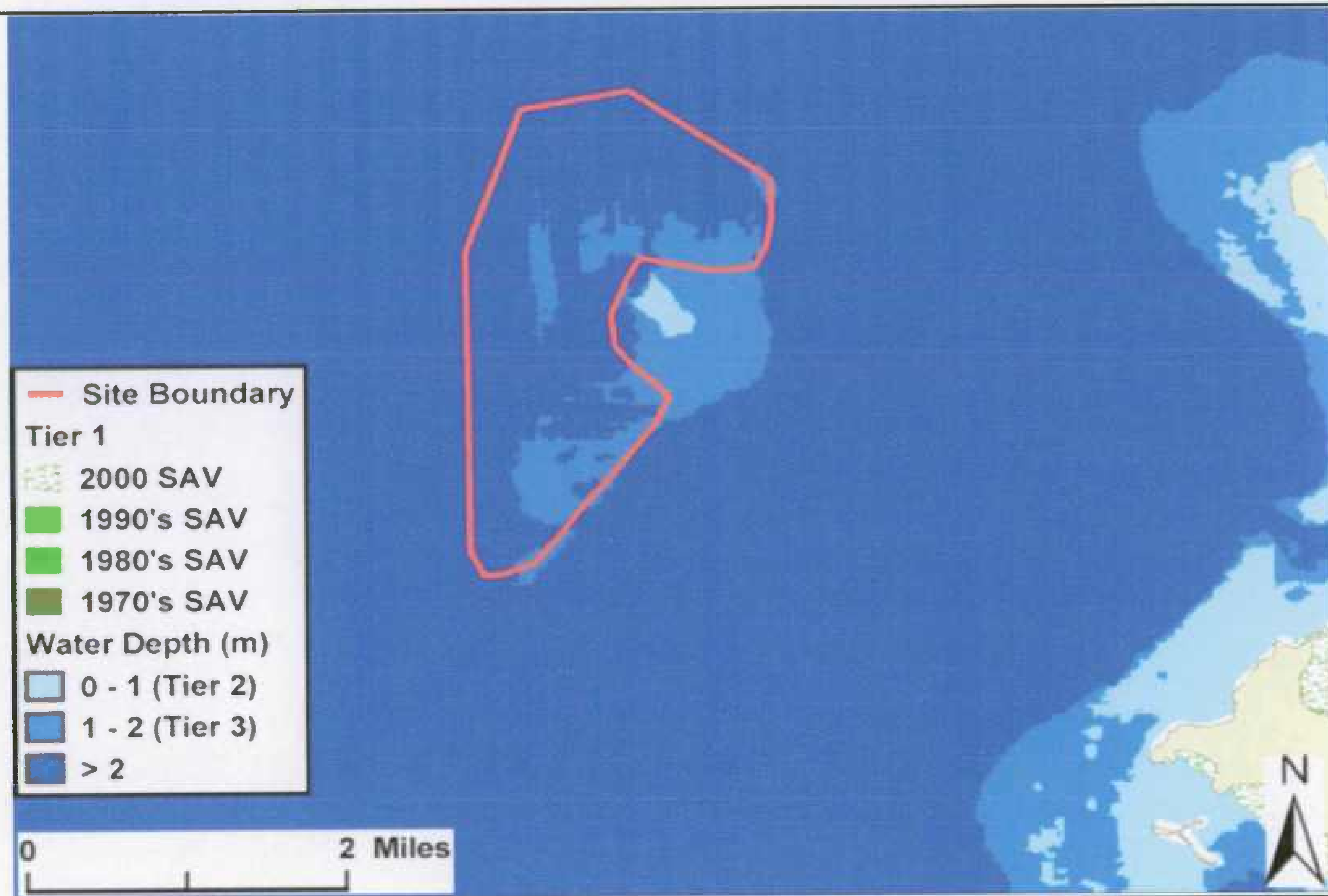
Draft Reconnaissance Study of Environmental Conditions at Sharps Island

Submerged Aquatic Vegetation (SAV) Bay Grass Acreage 1984-2000: Total Coverage for Outer Choptank River Area CHOMH1.

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 4-4

ms_03522002figs.xls_4-4_9/27/2002



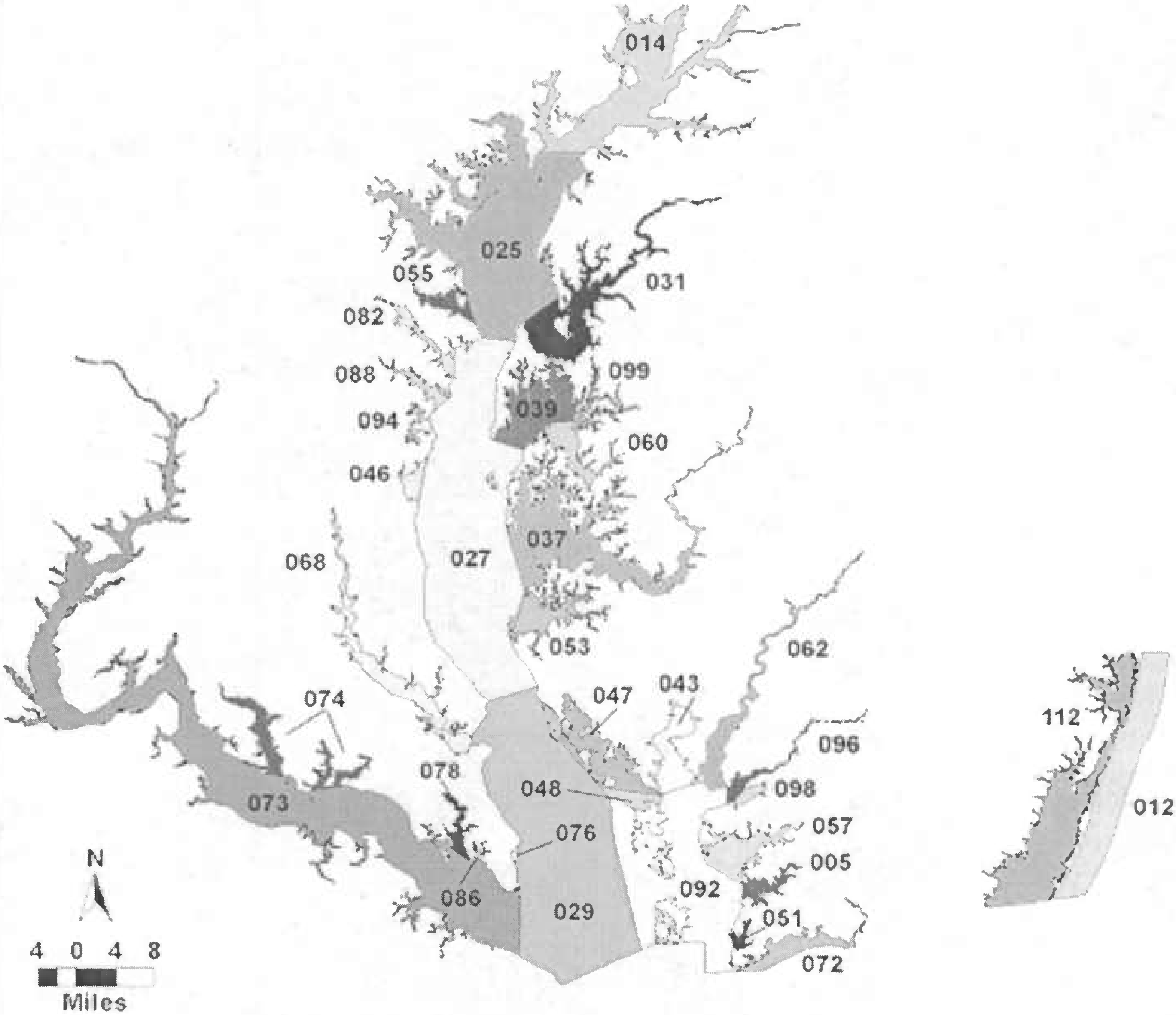
(Source: MDNR, 2002c)

Draft Reconnaissance Study of Environmental Conditions at Sharps Island

Water Depth and Trends in SAV Presence in the Vicinity of Sharps Island.

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 4-5



005 Big Annemessex River
012 Atlantic Ocean
014 Northern Chesapeake Bay
025 North Central Chesapeake Bay
027 South Central Chesapeake Bay
029 Southern Chesapeake Bay
031 Chester River
037 Choptank River
043 Fishing Bay
046 Herring Bay
047 Honga River
048 Hooper Strait
051 Little Annemessex River
053 Little Choptank River
055 Magothy River
057 Manokin River
062 Nanticoke River
068 Patuxent River
072 Pocomoke Sound
073 Potomac River
074 Wicomico River/Breton Bay
076 St Jerome Creek
078 St Mary's River
082 Severn River
088 South River
092 Tangier Sound
094 West/Rhode River
096 Wicomico River (Eastern Shore)
098 Moni Bay
099 Wye River
112 Maryland's Coastal Bays

(Source: MDNR Commercial Fisheries, 2002)

Draft Reconnaissance Study of Environmental Conditions at Sharps Island

NOAA's Harvest Codes for the Chesapeake Bay Region.

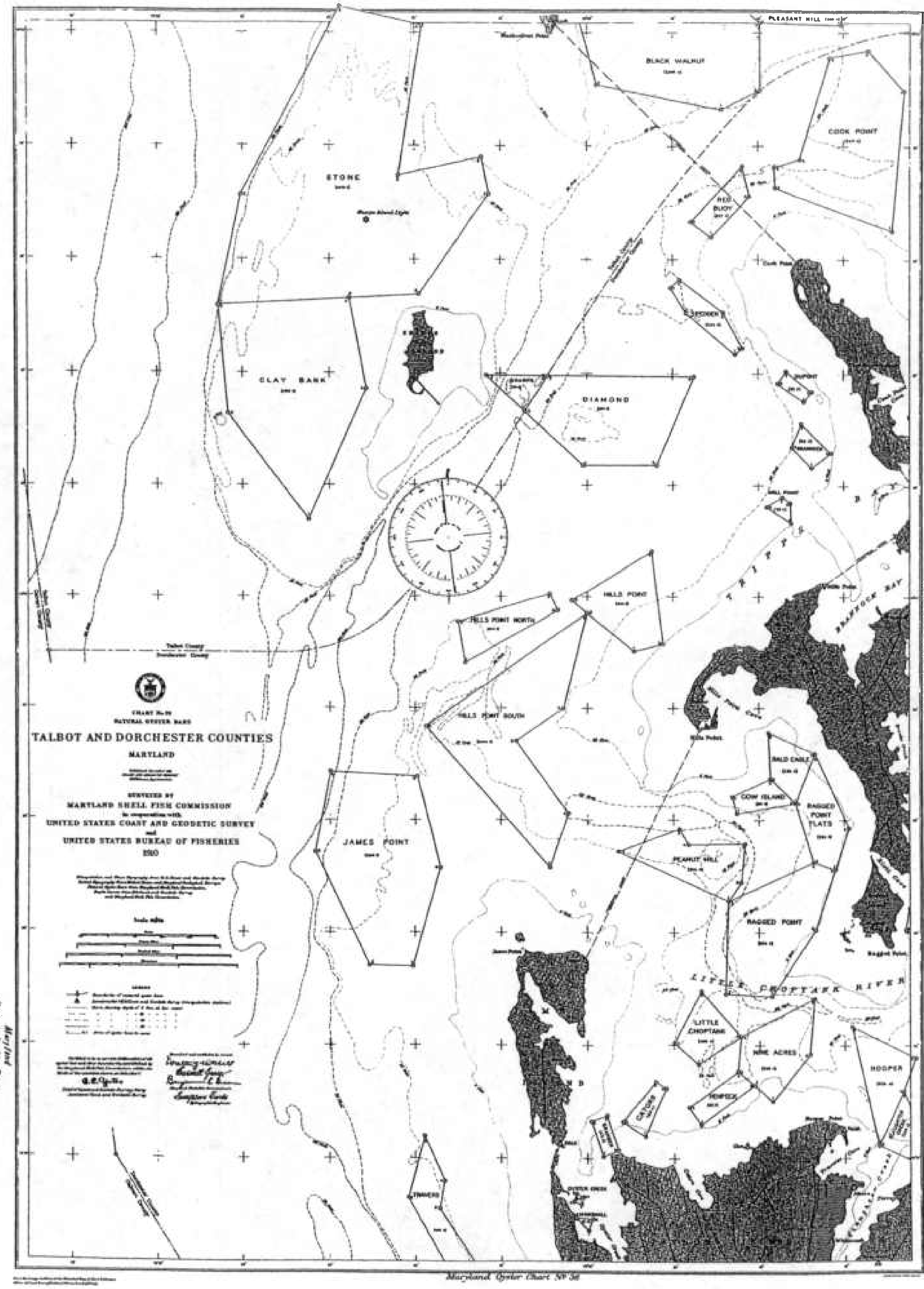
BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 5-1

Appendix A

Historical Oyster Bar Information for Sharps Island

BBL®
BLASLAND, BOUCK & LEE, INC.
engineers & scientists



Maryland Natural Oyster Bars

Appendix B

RTE Letters

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Parris N. Glendening
Governor

Kathleen Kennedy-Townsend
Lt. Governor

Maryland Department of Natural Resources

Tawes State Office Building
Annapolis, Maryland 21401

J. Charles Fox
Secretary

Karen M. White
Deputy Secretary

August 19, 2002

Mr. John B. Thelen
BBL Sciences
326 First Street, Suite 200
Annapolis, MD 21403-2678

RE: Environmental Review for Sharps Island, BBL Project #13603.002, Talbot County, Maryland.

Dear Mr. Thelen:

The Wildlife and Heritage Service has no records for Federal or State rare, threatened or endangered plants or animals within this project site. This statement should not be interpreted as meaning that no rare, threatened or endangered species are present. Such species could be present but have not been documented because an adequate survey has not been conducted or because survey results have not been reported to us.

However, the Wildlife and Heritage has an historical record for a Least Tern (*Sterna antillarum*) colony that used to occur on Sharps Island. Least terns are currently listed as state threatened in Maryland, and colonies within the Chesapeake Bay Critical Area are protected. If you should have any further questions regarding this information, please contact me at (410) 260-8573 or at the above address.

Sincerely,

Lori A. Byrne

Lori A. Byrne,
Environmental Review Specialist,
Wildlife and Heritage Service

ER# 2002.1429.ta

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401

September 10, 2002

Mr. John B. Thelen
Project Scientist
Blasland, Bouck & Lee, Inc.
326 First Street, Suite 200
Annapolis, Maryland 21403-2678

RE: Environmental Conditional Reconnaissance, Sharps Island, Talbot County, MD

Dear Mr. Thelen:

This responds to your letter, received July 22, 2002, requesting information on the presence of species which are federally listed or proposed for listing as endangered or threatened within the vicinity of the above reference project area. We have reviewed the information you enclosed and are providing comments in accordance with Section 7 of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*).

Except for occasional transient individuals, no federally proposed or listed endangered or threatened species are known to exist within the project impact area. Therefore, no Biological Assessment or further Section 7 Consultation with the U.S. Fish and Wildlife Service is required. Should project plans change, or if additional information on the distribution of listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to federally protected threatened or endangered species under our jurisdiction. For information on the presence of other rare species, you should contact Lori Byrne of the Maryland Wildlife and Heritage Division at (410) 260-8573.

An additional concern of the Service is wetlands protection. Federal and state partners of the Chesapeake Bay Program have adopted an interim goal of no overall net loss of the Basin's remaining wetlands, and the long term goal of increasing the quality and quantity of the Basin's wetlands resource base. Because of this policy and the functions and values wetlands perform, the Service recommends avoiding wetland impacts. All wetlands within the project area should be identified, and if construction in wetlands is proposed, the U.S. Army Corps of Engineers, Baltimore District, should be contacted for permit requirements. They can be reached at (410) 962-3670.

We appreciate the opportunity to provide information relative to fish and wildlife issues, and thank you for your interests in these resources. If you have any questions or need further assistance, please contact Charisa Morris at 410-573-4550.

Sincerely,

Mary Ratnaswamy

Mary J. Ratnaswamy, Ph.D.
Program Supervisor, Threatened and Endangered Species

Appendix C

Fisheries Resources Correspondences

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

MARYLAND SALTWATER SPORTFISHERMEN'S ASSOCIATION, INC.

7626 Baltimore & Annapolis Blvd., Glen Burnie, MD 21060-3530
(410) 768-8666, FAX (410) 768-5988

August 12, 2002

Kate Forsythe-Majchrzak
Chesapeake Environmental Management, Inc.
260 Gateway Drive, Suite 21-C
Bel Air, MD 21014

Dear Ms. Forsythe-Majchrzak,

I write to you on behalf of the Maryland Saltwater Sportfishermen's Association (MSSA) and its 7,000 members concerning proposed dumping of dredge spoils at Sharps Island and surrounding areas.

This area has traditionally been a fishing ground for recreational fishermen as well as charterboat clients. A variety of fish take up residence in or around the Sharps Island area. Bottom dwellers such as Atlantic croakers, Norfolk spot, white perch and weakfish (seatrout) have always been pursued and captured there. Our state fish, the rockfish, has shown great interest in the habitat at that location since many of them are caught there each year.

Finfish, as well as shellfish, are residents of the Sharps Island area and we should do everything possible to preserve their habitat. No open water dumping should be allowed which, in our opinion, will destroy this pristine habitat.

The Department of Natural Resources has been working with the many stakeholders of our resources for establishing artificial fishing reef programs to enhance habitat for our marine resources. Dumping dredge spoils in the open waters of the area known as Sharps Island would be very detrimental to that areas marine habitat.

We strongly urge you not to consider any dumping of dredge spoils in the Sharps Island area.

Sincerely,

Richard Novotny
Executive Director

State of Maryland
Department of Natural Resources

Natural Resources Police
Eastern Region - Area 2
3001 Starr Road, P.O. Box 157
Queen Anne, Maryland 21657
(410) 820-1314

Col. John W. Rhoads
Superintendent

LTC. Tammy S. Broll
Chief Field Operations

Capt. Michael E. Bloxom
Regional Commander

Lt. George N. Ball
Area Commander

August 13, 2002

Kate Forsythe-Majchrzak
260 Gateway Drive, Suite 21-C
Bel Air, MD 21014

Dear Ms. Kate Forsythe-Majchrzak,

In response to your letter requesting information about fisheries near Sharp's Island; any records the Department would have in regard to catches would be found in our Fisheries Department. Their phone number is 410-260-8279.

There are productive oyster bars in the immediate and surrounding areas of Sharp's Island. The closest clam fishery is approximately 1.5 miles away from the area. The area is used by several pound net fishermen for catching a variety of fish. There is some drift gill net fishing in the area during the striped bass gill net season. The blue crab fishery in the area is primarily crab pots of which many are used is this area.

If you have any more questions, please feel free to contact me At 410-820-1314.

Sincerely,

Sgt. Karen Haddaway
Natural Resources Police

Appendix D

Maryland Historical Society Letter

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Maryland Historical Society

201 West Monument Street
Baltimore, MD 21201-4674
Phone (410) 685-3750
Fax (410) 385-2105
www.mdhs.org

Library · Museum ·
Press · Public Programs

3 August 2002

Mr. John B. Thelen
BLASLAND, BOUCK & LEE, Inc.
326 First Street
Annapolis, MD 21403-2678

Dear Mr. Thelen:

Thank you for your letter of 17 July requesting historical information on Sharps Island, etc.

Our Senior Reference Librarian searched our Subject File and our OnLine Catalog with no success. Have you contacted the Talbot County Historical Society and/or Dorchester County Historical Society? I regret we were unable to supply the information you had requested and wish you success with your project.

Sincerely,

Donna Williams

Donna J. Williams
Acting Associate Director,
Local and Family History

djw

Appendix E

Department of Defense Letter

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

DEFENSE ENVIRONMENTAL RESTORATION ACCOUNT
FOR FORMERLY USED SITES
FINDINGS AND DETERMINATION OF ELIGIBILITY
SHARPS ISLAND AIR FORCE RANGE
SHARPS ISLAND, MARYLAND
PROJECT NO. C03MD038300

FINDINGS OF FACT

1. The Sharps Island Air Force Range is located 16 miles northwest of Cambridge, Maryland, and 38 miles southeast of Washington, D.C.

2. The U.S. Government acquired approximately 6.50 acres of land for Sharps Island Air Force Range through declaration of taking in 1943.

3. Sharps Island Air Force Range was used during World War II by the military personnel of Bolling Field, Washington, D.C., for bombardment and machinegun training.

4. Sharps Island Air Force Range was transferred from the Department of the Army to the Department of the Navy by memo in 1957. In June 1967, the Chief of Engineers, Washington, D.C., designated the installation as disposable. A final record audit was completed in 1967, when the accountability of the land records were transferred to the Department of the Navy.

5. The Department of the Navy continues to be the accountable agency for the property.

DETERMINATION

Based on the foregoing findings of fact, the site has been determined to be currently owned by Department of Defense. Therefore, it is determined that an environmental restoration project is not an appropriate undertaking within the purview of the Defense Environmental Restoration Account, established under Public Law 99-190, for the reasons stated above.

16 December 1986
Date

R.E. ABBOTT
COL, CE
Commanding

Encl 5